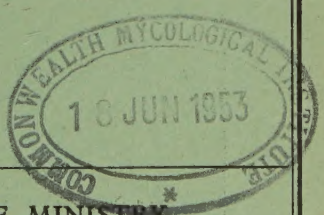
MYC

# N.A.A.S.

# Quarterly Review

## No. 20

## Summer 1953




LONDON: PUBLISHED FOR THE MINISTRY OF AGRICULTURE AND FISHERIES BY HER MAJESTY'S STATIONERY OFFICE

ONE SHILLING AND SIXPENCE NET

AGRICULTURAL RESEARCH COUNCIL

# SOIL SURVEY OF GREAT BRITAIN

Reports of the Soil Survey Research Board containing details of surveys carried out in England, Wales and Scotland during the post-war years.

| | | |
|---|---|---|
| No. 1. | 1946-47 and 1948. | 1*s.* 6*d.* (1*s.* 7½*d.*) |
| No. 2. | 1949 | 2*s.* (2*s.* 1½*d.*) |
| No. 3. | 1950 | 3*s.* (3*s.* 1½*d.*) |
| No. 4. | 1951 | 3*s.* 6*d.* (3*s.* 7½*d.*) |

*Prices in brackets include postage*

---

*Obtainable from*

HER MAJESTY'S STATIONERY OFFICE

at the addresses on the reverse of the title page or through any bookseller

# N.A.A.S.

# QUARTERLY REVIEW

## THE JOURNAL OF THE NATIONAL AGRICULTURAL ADVISORY SERVICE

No. 20 Summer 1953

Single copies price 1s. 6d. (1s. 7½d. by post). Annual Subscription 6s. 6d., including postage. SALE INQUIRIES should be addressed to the publishers at any of the addresses overleaf. EDITORIAL COMMUNICATIONS should be addressed to the Editor, N.A.A.S. Quarterly Review, Ministry of Agriculture and Fisheries, 3 Whitehall Place, London, S.W.1.

CONTENTS

ARTICLES *Page*

Soil Structure ... ... ... ... ... *E. W. Russell* 323
The Veterinary Investigation Service... ... *D. W. Menzies* 329

ABSTRACTS

Animal Breeding ... ... ... ... ... ... ... 336
Soils ... ... ... ... ... ... ... ... ... 337
Herbage ... ... ... ... ... ... ... ... ... 342
Crop Husbandry ... ... ... ... ... ... ... 344
Machinery ... ... ... ... ... ... ... ... 346
Fruit ... ... ... ... ... ... ... ... ... 348
Nutrition of Horticultural Crops ... ... ... ... ... 350
Vegetable Crops ... ... ... ... ... ... ... 354
Dairy Husbandry ... ... ... ... ... ... ... 355
Entomology ... ... ... ... ... ... ... ... 358
Virology ... ... ... ... ... ... ... ... 360

PROVINCIAL NOTE

Some Observations on the Occurrence and Correction of Nutrient Deficiencies in Fruit Trees and Bushes ... ... *F. A. Roach* 363

LONDON: HER MAJESTY'S STATIONERY OFFICE: 1953

## ABSTRACTORS

### AGRICULTURE

A. W. Stableforth, D.Sc., M.R.C.V.S., D.V.S.M. ... ... *Animal Health**
H. P. Donald, D.Sc., Ph.D., F.R.S.E. ... ... ... *Animal Breeding*
S. M. Boden, B.Sc., A.R.I.C. ... ... ... ... ... *Animal Nutrition**
W. Morley Davies, M.A., B.Sc., F.R.I.C. ... ... ... ... *Soils*
T. E. Williams, B.Sc. ... ... ... ... ... ... *Herbage*
D. H. Robinson, B.Sc., Ph.D., N.D.A. ... ... ... *Crop Husbandry*
C. Culpin, M.A. ... ... ... ... ... ... ... *Machinery*

### HORTICULTURE

H. B. S. Montgomery, B.A., Ph.D., D.I.C. ... ... ... ... *Fruit*
E. Skillman, B.Sc., N.D.H. ... ... ... ... *Glasshouse Crops**
Professor R. H. Stoughton, D.Sc., A.R.C.S.... *Flowers and Soilless Culture**
William Plant, B.Sc.(Hort.), Ph.D., N.D.H. *Nutrition of Horticultural Crops*
E. J. Winter, M.Sc. ... ... ... ... ... ... *Vegetable Crops*

### GENETICS

J. L. Fyfe, M.Sc. ... ... ... ... *Crops and Plant Breeding**

### DAIRYING

A. T. R. Mattick, B.Sc., Ph.D. ... ... ... *Dairy Bacteriology**
A. S. Foot, M.Sc. ... ... ... ... ... ... *Dairy Husbandry*

### POULTRY

R. Coles, M.Sc.(Econ.), B.A., Ph.D., M.Sc. ... *Poultry Husbandry**

### PLANT PATHOLOGY

L. N. Staniland, A.R.C.S. ... ... ... ... ... ... *Entomology*
H. E. Croxall, B.Sc., Ph.D. ... ... ... ... ... ... *Mycology**
Kenneth M. Smith, Ph.D., D.Sc., F.R.S. ... ... ... ... *Virology*

*Not represented in this issue.

---

In the interests of factual reporting, occasional reference in this Journal to trade names and proprietary products may be inevitable. No endorsement of named products is intended, nor is any criticism implied of similar products which are not mentioned.

---

*Crown Copyright Reserved*

PUBLISHED BY HER MAJESTY'S STATIONERY OFFICE

To be purchased from

York House, Kingsway, LONDON, W.C.2 423 Oxford Street, LONDON, W.1
P.O. Box 569, LONDON, S.E.1
13a Castle Street, EDINBURGH, 2 1 St. Andrew's Crescent, CARDIFF
39 King Street, MANCHESTER, 2 Tower Lane, BRISTOL, 1
2 Edmund Street, BIRMINGHAM, 3 80 Chichester Street, BELFAST
or from any Bookseller

# ARTICLES

## SOIL STRUCTURE

E. W. Russell

*Department of Agriculture, University of Oxford*

Soil structure embraces those properties associated with the size and shape of the crumbs and clods occurring in the soil; and thus it forms an important component of the complex group of properties that make up soil tilth. But structure also includes the distribution of cracks and channels between the crumbs and clods in the soil, and from the point of view of crop growth, this is its more important aspect. Roots will normally only grow in channels larger than a certain minimum size occurring in a well-aerated soil, so that this distribution will control the development of the crop's root system. For a moist soil to be well aerated, it must have both good drainage and a well-distributed system of air-filled pores extending from the soil surface down through the root zone. Hence, soil structure affects crop growth through its control of soil aeration. The two basic problems of soil structure then are, firstly, the production of a suitable system of air spaces throughout the soil, and, secondly, ensuring that these spaces last as long as possible : this latter condition is fulfilled if the crumbs and clods forming the soil are long lived.

Beginning with the pore space aspect of soil structure, it is found that if the soil is well aerated when wet, there are sufficient wide pores for the roots to enter to ensure that the crop will have an adequate root system. Now soils can only be well aerated if there is an adequate volume of air pores in each layer of the soil (beginning at the surface and going downwards) to allow the carbon dioxide, which is continually being produced in the soil, to diffuse into the atmosphere quickly, and so prevent too high a concentration in the soil. The number of pores should also be sufficient to allow oxygen to diffuse quickly from the atmosphere into the soil, where it is continuously being used up, and so keep the concentration there high enough to permit the growth of new roots and the proper functioning of the old. Dry soils always have sufficient air pores for adequate aeration, but wet soils can only contain air if they are well drained, and then only in those pores that can be emptied of water by drainage. The latter are pores that are emptied of water when wet soil is subjected to a suction of 20-40 inches of water (corresponding to pores having an equivalent diameter of about 50 microns or 1/500 inch). Such a system of pores will also guarantee that any surplus rainwater lying on the surface will drain through the moist soil quickly enough to prevent the crop roots being

injured by an excess of carbon dioxide or a deficiency of oxygen in the soil air.

## Creating a Good Structure

A suitable pore space distribution can be created in most arable soils by good cultivation. The ideal to aim at can be described most easily in terms of the size of the typical crumb forming the soil, for it is found that the optimum size of crumb for good plant growth, particularly early on in the growing season, lies between 1 and 5 mm. (1/25-1/5 inch). A seedbed with such a structure will give the correct physical conditions for the germination and early growth of the crop. Smaller crumbs than this will block the air channels in the wet soil, and larger ones will unnecessarily restrict the volume of soil the young roots can grow in. A distribution of crumb size almost fulfilling this condition can often be found just below the surface of old pastures and deciduous woodlands.

The methods which a farmer has at his disposal for altering the distribution of these larger pores and for creating more large pores per unit volume of soil, are the proper use of cultivation implements (including their effect in leaving the soil clods in a suitable condition to be made smaller by weathering and frost), and the correct use of crop rotations and organic manures. Drying a wet soil, particularly if it has a certain amount of clay in it, will cause it to shrink, and cracks will develop in the soil surface. The weaker the cohesion between the soil particles, the more cracks that will develop per unit area, but the narrower they will be. On the other hand, if the cohesion between the particles is high, as in a puddled clay, only a few wide cracks will be formed, leaving large clods between them. Freezing a wet clod also helps to break it up, for the water seems to move into definite films before it freezes and expands, thereby isolating small crumbs between these films.

Wetting a dry clod will often cause it to break into smaller clods, or cause a number of small crumbs to slake off its surface. The processes responsible for this are not altogether understood, but they include a break-up due to the uneven swelling of the clod as it becomes wet, and a further break-up due to air that seems to be released from the surface of dry soil particles when they are wetted. These processes form the principal weathering mechanism which breaks down the clods produced by ploughing into the fine crumbs needed for the seedbed. This disintegration of a clod structure into a crumb structure is not always desirable, for one of the secrets of maintaining a good structure in the surface of a sandy soil is to keep it lumpy and prevent it from slaking and forming a surface cap.

The structure of an arable soil is strongly influenced by the moisture content at the time it is worked. It is well known that ploughing a dry, poorly-structured, heavy soil tends to shatter the soil and leave it in moderately-sized clods that will easily break down to a suitable size for a seedbed after a short period of weathering. Ploughing a

sandy soil when it is wet will make it more lumpy; it can easily be shown in the laboratory that the strength or stability of these clods is very dependent on the moisture content of the soil. The clods have a maximum stability if the soil is worked when it is wet but well drained, and appreciably less if the soil is 2-3 per cent drier than this optimum moisture content. This effect of the moisture content at the time of ploughing on the stability of the clods has not yet, however, been demonstrated to be of importance in the field.

### Clay as a Soil Cement

The real problem of soil structure in the field, however, is usually not its production but its maintenance when produced. It is obvious that, if a soil is given a good structure, it could be maintained by impregnating all the crumbs with a waterproof cement that would hold all the soil particles in each crumb together, but would prevent one crumb from sticking to the next. The two principal cements that occur in British soils, namely, clay and humus, have these properties to some extent, hence their importance in all problems of structure stability.

The strongest cementing agent in most soils is the clay fraction : but there are several different types of soil clay, not all of which can act as efficient cements. The kaolinite type of clay, with low cation exchange capacity, has little cementing power, whilst the cementing power of the illite and montmorillonite type appears to increase with increasing cation exchange capacity. However, none of the soils with a high content of the kaolinite type of clay is important in this country. The actual mode of operation of the clay is still unproven, but since adding only 2-3 per cent of clay to a blowing sand can convert it into a soil, the clay presumably must be able to stick on to the sand grains. This is the reason why a very sandy soil can be improved by claying, although a heavy clay cannot be improved by sanding. In the latter case, slightly increasing the percentage of sand cannot break down appreciably the cohesion between the clay particles.

A clay cement is always strongest when the clay is dry; it may be weak, or even fail altogether, when the clay is wet. Hence, the important problem in soils, where clay is the main cement, concerns its behaviour on wetting. In the first place, wet clay is usually sticky, so pressing wet clay clods together will often be sufficient to convert them all into one mass. This is particularly liable to happen in clay soils high in montmorillonite clay, for such soils swell very markedly on wetting. Fortunately again, such soils do not seem to be of importance in this country.

Another very serious trouble with clay cements, occurring only very rarely here, is for the clay to lose completely its power of cementing when wet, in which case a dry clod will fall down to a mud on wetting. This occurs whenever the clay particles become deflocculated, as happens if the proportion of exchangeable sodium ions on the clay

rises above 10-15 per cent of the total exchangeable cations and the soil is then wet with rainwater. Such clays are produced in a soil temporarily flooded by sea water, and are usually cured by adding a cheap soluble calcium salt, normally calcium sulphate or gypsum, to the soil to allow the excess sodium to wash out as sodium sulphate.

## Organic Cements

Organic cements, the other important group, differ completely from the clays, since they are ephemeral products in the soil and are to a large extent under the control of the farmer. In fact, soils low in clay can usually only be kept in good structure if there is an adequate amount of organic cements present. The reasons soil organic matter, or more probably some fractions of the organic matter, can act as a cement is not known, but usually it seems to be through their interaction with the clay particles. In a soil containing appreciable amounts of clay, organic colloids are adsorbed on the surface of the clay particles, reducing the stickiness of the clay when wet and making the clay clods more friable when dry, presumably by increasing the average pore size between the clay particles. This effect is probably the cause of the observation that organic matter makes a tilth more mellow.

It is not yet known for certain what components of the organic matter in the soil have this property. It is probable that not all the colloidal organic matter has, for there is good evidence that land several years out of old pasture can have a poorer structure but a higher organic matter content than well-farmed arable soil. It is known that some bacterial gums containing uronic acid radicles can have this property, and that bacteria producing such gums are present in the soil, but most soils do not seem to contain enough of these gums for this to be a sufficient mechanism. Other components of the organic matter (of undetermined composition) seem to have this property, and also synthetic soil conditioners, such as krilium. The mechanism of this adsorption is still the subject of experiments.

The question now arises whether these humic cements can bind sand particles together, for all the discussion so far has centred on the adsorption of the humic colloids on the clay particles. The answer appears to be that only a small part of the improvement in structure of a sandy soil brought about by adding large amounts of farmyard manure, for example, is due to a direct binding of sand particles together by these cements, but little work seems to have been done on the interaction between sand particles and organic colloids.

The analysis of the role of organic matter in stabilizing soil structure is complicated, because one does not, in fact, add humic colloids (very resistant to decomposition) to the soil, but decomposable organic matter such as farmyard manure ; or else the land is put down to grass for a number of years. In either case this alters the composition of the soil organisms appreciably, because their food supply has been

increased, and the observed improvement in structure brought about by these methods may be due more to the micro-organisms themselves than to the humic colloids. It is certainly true that some pure cultures of fungi, and probably of bacteria also, if allowed to multiply in a sterile soil, will improve its structure. However, this does not prove that this mechanism is of any importance in the very mixed population present in a normal soil.

Putting land down to grass for several years may improve its structure, and this structural improvement may be noticeable several years after the ley has been ploughed out, but the actual reasons for this improvement are not known. Typically, the humus content of the soil is increased, and doubtless this causes a higher micro-organic population—particularly when it is ploughed out. These effects may be of importance, yet the impression is growing that the grass roots themselves are playing an active part in the build up of structure, and it is certainly sometimes true that as the grass roots decompose after the ley is ploughed out, so the structure deteriorates. Most ordinary observations will not discriminate between the various processes. Thus merely putting land down to grass does not ensure a good structure, as can be seen on some reclaimed opencast coal sites. This is probably because of an inadequate root system, though it might be partly due to inadequate top growth (and hence only a low return of animal droppings and dead leaves to the soil surface), and partly to an absence of earthworms to mix these residues with the surface soil.

Another problem of unknown importance on the organic side is the role of undecomposed fibre in the improvement of structure brought about by farmyard manure and leys. This fibre, whether bits of straw or plant roots, presumably helps to keep the soil open. It will sometimes act as a drainage channel for water, and this process may be of great importance in the surface of sandy soils low in organic matter. In fact, it has been suspected on several occasions, though not yet proved, that a long unrotted farmyard manure is preferable on some sandy soils to a short well-rotted one. The long manure tends to keep the soil more open and better aerated during rainy weather, although the short manure presumably puts up the humus content and the water-holding capacity of the soil more than the long.

### Mulches, Cover Crops and Earthworms

Other methods for bringing about a marked improvement in the structure of the surface soil are covering it with a mulch, or with a low, close-growing crop that completely covers the surface. In each case the surface structure itself is protected from the beating and disintegrating effect of fast-falling rain, as well as from the strong drying action of direct, hot sunshine. Normally a mulch of compost, manure, straw or cut grass is used, and it is tempting to assume that the improved structure is due to earthworms working this organic mulch into the

surface soil, which then decomposes to form humus, and that these two processes are responsible for the improved structure. But the structure improvement seems to be due to some unexplained physical factor, for workers in Uganda have found that the same improvement took place in the surface of a structureless soil when it was covered with a gravel mulch containing DDT, and it appeared that the DDT was effective in preventing animal activity in the soil surface.

The role of soil animals, and particularly earthworms, in producing or maintaining soil structure, is again undecided. The principal result of recent work has been to stress the importance of distinguishing between the various species of earthworms present in the soil, because of their very different effects on the soil structure. The three largest species all make burrows from the surface down into the subsoil, and all normally ingest soil along with their food, but only two of these species make their casts on the soil surface. These species are normally the principal ones in pasture soils, and although their burrowings affect the soil structure appreciably, their casts can hardly be of great importance. Rarely more than 40 tons of soil per acre will pass through their digestive tract in a year, whereas the volume of soil in which they work—the top 4-6 inches—weighs between 500 and 1,000 tons per acre. In arable soils, only the smaller species of earthworms are important, and as these pass a great deal less soil through their digestive tract, it is difficult to believe that they can affect the structure appreciably.

### Chalk Dressings on Clay

A final problem worth mentioning is the alleged effect of large dressings of chalk—20-40 tons per acre—in improving the structure of heavy clay soils. It is certainly a traditional belief held by clayland farmers in some parts of this country. But in spite of a certain amount of detailed work in which possible benefits from dressings of calcium carbonate at that rate were looked for, no soil property connected with structure or tilth has been found which appears to be dependent on the free calcium carbonate in a clay. It is possible that if this effect really exists it will be found when acid clays rather high in organic matter are limed, for the lime will encourage the decomposition of the organic matter, and this in turn will improve temporarily the structure as well as the supply of available nutrients in the soil. It remains one of the few examples of a traditional practice that has received no adequate scientific explanation, unless it is the simple one of completely misinterpreting the benefits of neutralizing soil acidity.

# THE VETERINARY INVESTIGATION SERVICE

D. W. Menzies

*Superintending Veterinary Investigation Officer,*
*Ministry of Agriculture and Fisheries*

The Agricultural Advisory Service of England and Wales was developed between 1911 and 1914, with centres based on Universities or Agricultural Colleges, and some ten years later the first veterinary advisory officers were appointed to the advisory centres at Cardiff, Bangor and Newcastle. In the following decade, appointments were made to the remaining centres. In 1935 the officers were renamed "Veterinary Investigation Officers" and, in 1946, the service was incorporated into the Ministry of Agriculture and attached to its Animal Health Division, with the Veterinary Laboratory, Weybridge, as headquarters. The districts served by the Veterinary Investigation Service correspond to the old Provincial Agricultural Advisory areas, although two areas—those served by Newcastle and Reading—have been divided.

The Veterinary Investigation Officer is in charge of the technical staff at the regional laboratory, which is equipped to carry out all the commoner methods of diagnosis of disease among domesticated animals. He is available for consultations by veterinary surgeons and veterinary practitioners in the area and assists them in the diagnosis of causes of illness and disease in all types of livestock. He is also available for consultation by the field staff of Animal Health Division and officers of the N.A.A.S.

The work at a centre is largely concerned with routine examinations of material submitted for examination by veterinary surgeons, such as milk samples for the presence of mastitis organisms ; faeces samples for the presence of worm eggs, fluke eggs, coccidia, Johne bacilli, or pathogenic organisms such as salmonellae ; and blood samples for agglutination test against brucella abortus or salmonella pullorum. In addition, carcasses or portions of organs from poultry, pigs, sheep and cattle are examined. The object of the examinations, whether bacteriological or parasitological, is, of course, to determine the cause of the condition and devise measures to control further losses. These routine examinations frequently put the Veterinary Investigation Officer into contact with new local problems, which he investigates. The disease conditions dealt with are numerous and varied and it is not possible to detail many of them.

In January each year, a conference of all professional staff is held at Weybridge. The following conditions, which were dealt with at the 1953 Conference, provide examples of the investigations undertaken at one or more regional centres.

## Cattle

### HYPOCUPROSIS

For several years blood samples have been submitted to the Veterinary Laboratory, Weybridge, for copper estimation, and it has been established that copper deficiency occurs in many parts of Great Britain. The deficiency affects cattle of all ages, but symptoms are most marked in the young, actively-growing calf. Recent work in East Anglia shows that copper deficiency depresses the growth of calves and yearling cattle by approximately one-third. Controlled trials have been carried out to find methods of prevention which can be used under ordinary farming conditions. One trial showed that symptoms of deficiency in calves could be prevented by dosing cows during pregnancy with copper sulphate. Calves from dosed cows thrived normally, whereas calves from undosed control cows all developed symptoms of deficiency when 9-10 weeks old. In yearlings, symptoms were prevented by feeding a daily supplement of cake containing copper sulphate during the winter months. It was also found that the disease could be prevented by top dressing the pastures in the spring with copper sulphate shortly before calving began, and, under these conditions, adult cows and calves did better than cattle grazing untreated pastures.

From the information obtained in the experiments, the liveweight gains of normal and deficient cattle from birth to 30 months old are estimated as follows :

| Age | Management | Normal Cattle | | Deficient Cattle | |
|---|---|---|---|---|---|
| | | Weight | Daily Live-weight Increase | Weight | Daily Live-weight Increase |
| *months* 0 | | *lb.* 90 | *lb.* | *lb.* 90 | *lb.* |
| 5 | At pasture with dams, May-Sept (153 days) | 426.6 | 2.2 | 319.5 | 1.5 |
| 12 | Weaned in yards, Oct.-April. (212 days) .. | 638.6 | 1.0 | 531.5 | 1.0 |
| 18 | At pasture, May-Oct. (184 days) .. .. | 878.7 | 1.305 | 697.8 | 0.904 |
| 24 | In yards, Nov.-April. (181 days) .. .. | 1,009 | 0.72 | 810 | 0.62 |
| 30 | At pasture, May-Oct. (184 days) .. .. | 1,277 | 1.457 | 936 | 0.685 |

It will be observed that the " deficient " cattle, when moved into yards on supplementary foods, achieved weight increases comparable

with those of normal cattle. The reduced weight gains always occurred while the animals were on pasture. The " normal " cattle can be graded during their third summer, i.e., before they are two-and-a-half years old, at a live weight of 11-12 cwt., whereas it is necessary to keep the copper-deficient cattle until the following summer.

### Bracken Poisoning of Cattle

Bracken poisoning of cattle occurs all over Great Britain, often between July and September. The incidence of the condition varies from year to year and, contrary to the accepted view that animals rarely eat plants of a poisonous nature if ample herbage is available, cases of bracken poisoning have occurred on good pastures with a small area of bracken in one corner. Work on the problem was undertaken at Aberystwyth in collaboration with the staff of the University College of Wales. For many years it was argued that the trouble was not bracken poisoning, but an acutely infectious disease. In the earlier years, animals under experiment died after they had eaten about 2 cwt. of the plant, but in some instances the bracken comprised the whole ration and it was suggested that death was actually due to starvation. The Aberystwyth workers arranged controlled experiments and fed harvested bracken and bracken which had been heated for half-an-hour at 208-210°F., and supplemented this with hay and high protein cake and, in one group, molasses. The results of these experiments are summarized in the following table.

| Treatment | Length of Experiment | Amount of Bracken Eaten | Result | Weight Variation |
|---|---|---|---|---|
| | *days* | *lb.* | | *lb.* |
| Bracken .. .. | 57 | 285 | Died—bracken poisoning | −5 |
| Bracken .. .. | 56 | 280 | Died—bracken poisoning | −33 |
| Heated bracken .. | 83 | 750 | Alive | −30 |
| Heated bracken .. | 83 | 750 | Alive | −28 |
| Bracken and molasses | 69 | 350 | Died—bracken poisoning | −69 |
| Bracken and molasses | 55 | 275 | Died—bracken poisoning | −77 |
| Bracken .. .. | 60 | 300 | Died—bracken poisoning | −12 |
| Heated bracken .. | 80 | 740-750 | Alive | +19 |

It will be seen that bracken contains a toxic substance which can be inactivated by heat. Characteristic changes occur in the blood picture

of affected animals, notably a marked fall in the number of white blood cells, and these changes are the object of further study. Feeding experiments carried out last winter have confirmed the earlier findings relating to the toxicity of the plant.

### Mastitis

Apart from the routine examinations of milk samples from individual cases of mastitis, which in many cases are from cows which have failed to respond to treatment, a special study has been made of the disease as a herd problem. This involves bacteriological examinations, at frequent intervals, of milk samples from all the milking cows, and the procedure largely depends on the type of organism which predominates. Streptococcus agalactiae is sensitive to penicillin, and a large number of herds have been cleared of this infection by treating with penicillin animals found to be infected. Further tests and treatment are often necessary, as a small " core " of infected cows may remain after the first treatment. As an example of what can be achieved, the results in 24 herds under supervision from the Bristol centre are given in the table on p. 333.

In all these herds, the full co-operation of the farmer was obtained—this is essential to success. It will be observed that the best results were obtained in herds where the milking machine only was used.

The problem of the types of mastitis caused by other organisms is being studied in a number of herds, special attention being paid to staphylococcal mastitis.

### Vibriosis

Abortion in cattle and sheep as the result of vibrio foetus infection has been recognized for many years, but it is only recently that this organism has been implicated as a cause of infertility in dairy cattle. The disease is diagnosed by the recovery of the organism from aborted foetuses, or by the application of the mucus agglutination test, devised by J. Lawson at Weybridge. There is no doubt that infection is transmitted by the bull, although it is extremely difficult to confirm the existence of the infection in this animal, except by using him on maiden heifers. Cows that contract infection usually develop an immunity after some months. The disease appears to be widespread in Great Britain, and information concerning it is being collected at all centres. A limited number of observations have been made on the value of penicillin in the treatment of infected cows and bulls, but the results are difficult to assess, partly because of the natural immunity which the cows develop and partly because it is often difficult to check the service records on farms which are under observation. Critical experiments now in progress at the Veterinary Laboratory, Weybridge, have already contributed greatly to our knowledge of this disease.

Other problems being investigated intensively include the control of Johne's disease on a number of farms, with the help of the blood test devised by N. Hole at Weybridge; the studies of the epidemiology of

**Results of Treatment with Penicillin of Mastitis caused by Streptococcus Agalactiae**

| Method of Milking | Original Position | | | After One Year | | | After 18 months | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total No. of Cows | No. Infected | Percentage Infected | Total No. of Cows | No. Infected | Percentage Infected | Total No. of Cows | No. Infected | Percentage Infected |
| Machine only (9 herds) .. | 244 | 47 | 19.5 | 207 | 4 | 2 | 220 | 2 | 1 |
| Machine plus hand stripping (10 herds) .. | 291 | 68 | 23.4 | 281 | 17 | 6 | 274 | 16 | 5.8 |
| Hand (5 herds) .. | 160 | 49 | 31 | 143* | 11 | 7.7 | 146 | 12 | 8.2 |

Of these 24 herds, 16 have completed two years' treatment, and the results of these herds follow a similar pattern :

| Method of Milking | Original Position | | | After One Year | | | After 18 months | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total No. of Cows | No. Infected | Percentage Infected | Total No. of Cows | No. Infected | Percentage Infected | Total No. of Cows | No. Infected | Percentage Infected |
| Machine only (5 herds) .. | 112 | 23 | 20.5 | 103 | 1 | 1 | 102 | — | — |
| Machine plus hand stripping) (7 herds) .. | 233 | 52 | 22.4 | 220 | 14 | 6.5 | 213 | 7 | 3.3 |
| Hand (4 herds) .. | 148 | 46 | 31 | 134* | 11 | 8.2 | 130† | 9 | 6.9 |

* One herd changed to machine milking during the year with improved results. † A second herd changed to machine milking during the year with improved results.

salmonella infection of animals at several centres; and continued work on diseases of young calves, notably white scours and, later in life, parasitic gastro-enteritis.

## Sheep

### ENZOOTIC ABORTION

A serious type of abortion has long been recognized in the border counties, and following the discovery by the Edinburgh workers that the disease was caused by a small organism belonging to the psittacosis lymphogranuloma group, a vaccine was quickly evolved and extensive field experiments were conducted, both in Scotland and northern England. Our own contribution to this, at Newcastle, can be summarized as follows:

| | 1951 | | 1952 | |
|---|---|---|---|---|
| | Vaccinated | Not Vaccinated | Vaccinated | Not Vaccinated |
| Total number of ewes .. .. | 1,262 | 1,233 | 844 | 991 |
| Total number of abortions (all types).. .. | 38 | 61 | 15 | 45 |
| Percentage of abortions .. | 3.0 | 5.0 | 1.6 | 4.5 |
| Proportion of placentae found to be infected | 15 out of 26 (57.7 per cent) | 36 out of 41 (87.8 per cent) | 5 out of 10 (50 per cent) | 24 out of 27 (89.6 per cent) |
| Hence, estimated number of infectious abortions .. .. | 22 | 54 | 8 | 40 |
| Estimated percentage of infectious abortions .. .. | 1.7 | 4.4 | 0.8 | 4.0 |

*Notes* 1. Ewes were vaccinated for the first time in 1950.
2. No gimmers are included in the figures for 1952 as they were vaccinated for the first time only in autumn 1951.

These results show that the incidence of enzootic abortion is reduced in the first pregnancy following vaccination, and that the effect is even more pronounced in the second pregnancy after vaccination. This agrees the results of similar experiments in Scotland.

Enzootic abortion has been confirmed in the last two years in some of the midland and south-western counties, but in these areas the disease crops up only sporadically, often as a result of importation of

infected sheep, and it is by no means as serious as it is in the northern counties.

### Pulpy Kidney Disease

Pulpy kidney disease is widespread and affects sheep of all ages and at all times of the year. It is probable, however, that the highest mortalities occur in spring, with the first flush of grass, and in autumn or early winter, when lowland sheep move from grass to root crops. That diet has an influence on the incidence of the disease is well established, but the exact role the diet plays is still unknown. The organism responsible, Cl. welchii, Type D, is one of a group which has been extensively studied, and effective serum and vaccine have both been manufactured. Consideration has had to be given to the best way to use these products. It is known that the administration of serum will immediately cut short an outbreak of pulpy kidney disease—but is it possible to confer a long-lasting immunity on the sheep? Trials involving over 2,000 sheep, using serum alone, serum and vaccine, and vaccine alone, have been carried out at Newcastle. In this preliminary work, serum and vaccine, and vaccine alone, appeared to be of equal value and were much more effective than serum alone. A modified vaccine, which it is hoped will stimulate a greater immunity, is being tested further in the field.

Other conditions affecting the sheep and becoming increasingly serious hazards are enzootic pneumonia and the metabolic disorders, such as hypomagnesaemia and hypocalcaemia. The aetiology of all these conditions is obscure and they have been subjects of preliminary investigation at several centres. Trials on the effects of cobalt deficiency have also been conducted in Herefordshire and Worcestershire.

## Pigs

While pig diseases of bacterial origin are relatively few—swine erysipelas being the classic example—losses from other causes have been fairly serious. Cases of bowel oedema have occurred throughout the country, but investigations made from the various veterinary investigation centres have failed to establish common factors relating to outbreaks which may form the basis for fundamental research into the problem. It appears to occur under all conditions of management and feeding. Workers in Ireland have reproduced the disease by inoculating experimental pigs with intestinal contents from typical cases, and this work has been confirmed in England, but the cause of the disease and specific therapy for prevention or treatment have not so far been evolved.

Investigations have been made into losses among very young piglets. In most cases litters have been normal at birth, but within twelve or twenty-four hours the piglets have become sleepy and dull, lapsing into a deep coma followed by death. In many of the piglets there is a low blood sugar, and the administration of glucose in the early stages sometimes brings about recovery. Others respond temporarily and

then relapse. Deaths in piglets four to five days old have also been common and the possibility of bacterial infection has been ruled out. These losses may be associated with management, but up to the present the exact cause has not been ascertained.

A severe dermatitis of piglets has been encountered. This responds almost miraculously to treatment with yeast products. Other conditions affecting pigs which have been studied include virus pneumonia and necrotic enteritis.

### Poultry

All the veterinary investigation centres undertake blood testing of flocks outside the Accredited Scheme for the control of pullorum disease. In the course of routine post-mortem examinations for the diagnosis of common ailments (coccidiosis, lymphomatosis, etc.), more serious infections, such as fowl typhoid and infectious laryngo-tracheitis, are sometimes encountered. In the last few years there has been an increase in fowl typhoid, and investigations have been conducted at Aberystwyth and Bangor. An extensive programme of work on the epidemiology of fowl typhoid is at present going on in the East Riding of Yorkshire, where sixty-nine outbreaks are known to have occurred in 1952. The organism recovered from many cases is unusually virulent, and viability and survival experiments are in progress. Vaccination and/or treatment trials have been planned.

It is hoped that these brief notes will provide some idea of the diversity of the work conducted at veterinary investigation centres. The results of the routine examinations are embodied in reports to veterinary surgeons and poultry-farmers, but a much more complete record of many of the research projects mentioned above can be found in the scientific literature.

# ABSTRACTS

## ANIMAL BREEDING

### Fertility of Inter- and Intra-Breed Matings

There has long been a belief among breeders that matings between breeds are more fertile than those within breeds. This question arose again when, during an investigation into the physiological aspects of infertility, Casida [1] found that Guernsey cows which would not hold to Guernsey semen held to that from Holstein-Friesians. The animals had been selected for repeated return to insemination but had all dropped at least one calf previously and had no genital abnormalities or discharges.

In the first year, 66 per cent of cows slaughtered three days after insemination had fertilized eggs, while only 23 per cent had normal embryos when slaughtered thirty-four days after insemination. This implies an embryonic death rate of 65 per cent. In the following year conception rates for Holsteins were much the same, but those for Guernseys were greatly reduced. When the Guernseys were inseminated with Holstein semen, however, they showed 70 per cent fertilization at three days and 56 per cent at thirty-four. It was felt that their original infertility might therefore have been due to pure-breeding, despite the fact that in the field the non-return rate of first-service females to the Guernsey bulls was almost as high as that to the Holsteins.

The problem was therefore further investigated [2] on a group of Holstein and Guernsey cows selected in similar manner. Half of each breed group was cross-bred, the rest being pure-bred as controls. A higher percentage of normal embryos was found in the Holstein than in the Guernsey cows, but only 16 out of 33 cross-bred matings were fertile, as against 28 out of 33 pure-bred matings.

These inconclusive results led to another study [3], this time of over 2,000 first-service inseminations from a number of Holstein and Guernsey bulls. Once again fertility was slightly higher for the Holstein bulls (67.4 per cent as against 65.7 per cent), a difference which became significant when all matings were considered. Non-returns to inseminations, made on the same day by the same technician with semen from the same bull, showed no significant differences in the fertility of within-breed and between-breed matings. It was therefore suggested that breed of bull might have had a greater effect on fertility than breed of cow or type of mating.

References

1. The Repeat-Breeder Cow. L. E. Casida. *Vlaams Diergeneesk. Tijds.*, 1950, **19**, 273-83.
2. The Response of Low-fertility Cows to Insemination with Semen from Bulls of another Breed. R. E. Christian, L. C. Ulberg and L. E. Casida. *J. Dairy Sci.*, 1951, **34**, 988-91.
3. The Fertility of Interbreed vs. Intrabreed Matings as Determined from Artificial Breeding Data. E. L. Corley, N. D. Bayley and F. A. Hendrickson. *J. Dairy Sci.*, 1952, **35**, 963-5.

K. v. O.

## SOILS

**The Estimation of the Lime Requirements of Soils.** T. W. Walker. *J. Soil Sci.*, 1952, **3**, 261-76.

This paper deals with soil and crop yield data from a long-term liming experiment carried out at Harper Adams Agricultural College from 1928 to 1944, and with liming experiments carried out by Advisory Chemists, started in 1944.

With the development of the ideas of *p*H and base exchange, and the recognition of the varying degrees of tolerance of the main agricultural

crops to the soil-acidity complex, present methods for estimating lime requirements were developed. These measure the amount of lime needed to bring the *p*H of a soil in the laboratory to a desired level. Two methods are mentioned as being in common use in advisory work in England and Wales : (1) a modification of the Smith and Coull buffer-curve technique (1932), which assesses the amount of lime needed to bring the *p*H of a soil to 6.5, giving results in close agreement with the Hutchinson-McLennan method ; and (2) the estimation of the exchangeable CaO, including any free calcium carbonate if present in small amount, this method being used chiefly in Wales.

Both of these methods estimate soil properties which can be accurately measured in the laboratory, but difficulty arises in translating laboratory lime requirements to field lime requirements. Experiments have shown that the soil in the field needs more lime to bring its *p*H to a given value than would appear to be so from laboratory tests, and various workers have suggested amounts varying from about one and a half to three times as much. These figures are called field factors. Unfortunately, in many cases in these investigations changes in *p*H values or calcium status were followed, but were not accompanied, by experiments designed to assess the effect of different rates of lime on crop yields.

Crops vary in their tolerance to soil acidity, and to be on the safe side the lime status of soils must be raised so that it is safe for the most sensitive crop in the rotation. The possibility of inducing micronutrient deficiencies, such as manganese or boron, by liming certain soils to a *p*H of 6.5 or more must also be borne in mind.

When making liming recommendations in the field, it is generally assumed that only the surface soil to a depth of 6-8 inches is involved. This may need modification for deeper ploughing as, apart from the greater amount of soil brought into cultivation, *p*H may vary greatly with depth.

In view of the many difficulties involved in interpreting laboratory estimates of lime requirement, it is surprising how few field experiments have been carried out in Britain to compare the effects of different rates and types of liming materials on crop yields. It is the purpose of this paper to present data from various trials that will permit some evaluation of laboratory methods and the interpretation of the results.

Harper Adams College Liming Experiment, 1928-44. This experiment tested finely ground limestone at rates of 0, 25, 50 and 100 cwt. per acre on a light loam soil of *p*H 4.7 and lime requirement of about 40 cwt. $CaCO_3$ per acre, as determined by the Hutchinson-McLennan method. Manurial treatments and cropping were uniform over the whole experimental area. Crop yields were taken and determinations were made each year in the spring of the *p*H, exchangeable CaO, free $CaCO_3$ and the Hutchinson-McLennan lime requirement.

Crop yields were taken for the years 1929-39, and Table I gives the mean yields for the first two crops and for the 1939 crop (eleven years after liming).

**Table 1**
**Mean Yields from Three Crops with Different Rates of Liming**

| Year | Crop | $CaCO_3$ per Acre (*cwt.*) | | | |
|---|---|---|---|---|---|
| | | *0* | *25* | *50* | *100* |
| 1929 | Barley (*cwt.*) .. .. | 9.3 | 15.1 | 16.1 | 17.1 |
| 1930 | Sugar beet (*tons*) .. | 4.1 | 9.1 | 10.3 | 10.1 |
| 1939 | Sugar beet (*tons*) .. | 1.0 | 2.5 | 5.8 | 7.8 |

The first five crops were all sensitive to acidity and provide a drastic comparison of the different liming rates. On the average, liming at 100 cwt. $CaCO_3$ per acre, or two and a half times the laboratory requirement, gave approximately 5 per cent higher yields than the 50 cwt. dressing. The beet crop grown eleven years after liming showed marked benefits from the heavier liming rates. Over the entire period of the experiment, during which a higher proportion of acid-sensitive crops was grown than in an average farm rotation, the 50 cwt. dressing gave 98 per cent of the yield of dry matter given by the 100 cwt. dressing, the 25 cwt. dressing gave 81 per cent, and the no-lime plots gave 30 per cent.

The highest *p*H of the soils was reached 4-5 years after application of the lime ; it was 6.8 for the 100 cwt. dressing, 6.1 for 50 cwt., and 5.6 for the 25 cwt. dressing, and if lime had been used at the lime-requirement rate of 40 cwt. $CaCO_3$ per acre, the highest *p*H would probably have been 5.8-6.0. The results show that not until 4-5 years after liming would a fairly reliable assessment of lime requirement from *p*H determinations be possible. As in the case of *p*H values, the time taken for the maximum effect of lime in reducing the estimated lime requirements was also 4-5 years.

The maximum exchangeable CaO values were not reached for 4-5 years, and free $CaCO_3$ persisted for 5-6 years on the most heavily dressed plots, and for 3-4 years on the other plots. There was a gradual reduction in the CaO present in the soil as exchangeable calcium and free $CaCO_3$, showing losses of lime throughout the period of the experiment, the losses being greater in the earlier years for the heavier dressings. The results suggest that, given a satisfactory sampling technique, the estimation of exchangeable calcium plus free $CaCO_3$ gives the most satisfactory picture of the actual calcium status of the soil. There was an average loss of approximately 8 cwt. $CaCO_3$ per year during the first five years and 2 cwt. for the third five years from the 100 cwt. plots, while the corresponding losses from the 25 cwt. plots were 3 cwt. and $\frac{1}{2}$ cwt. $CaCO_3$ per year respectively.

Liming Experiments Carried Out by Advisory Chemists. One of the main objects of these experiments, started in 1944, was to compare different liming materials when used at lime-requirement rates estimated by the Hutchinson-McLennan or similar methods. In each experiment a standard liming material—ground burnt lime—was used at nil, half,

and full lime-requirement rates, and various liming materials were used at full rates. In one series of experiments, three ground limestones of definite fraction size were compared with burnt lime. The average results of eight experiments over a period of four years are shown in Table 2.

**Table 2**

**Comparison of Results of Eight Experiments Using Burnt Lime and Three Grades of Ground Limestone**

| | No Lime | CaO at Half Rate | CaO at Full Rate | $CaCO_3$ at Full Rate | | |
|---|---|---|---|---|---|---|
| | | | | *20-40 mesh* | *40-100 mesh* | *100 mesh* |
| Average *p*H | 5.0 | 5.4 | 5.8 | 5.7 | 5.8 | 6.1 |
| Yields as percentage of general means .. | 58 | 103 | 109 | 107 | 110 | 113 |

These results indicate that the finest fraction of limestone gave the biggest rise in *p*H, and that the result from ground burnt lime was equivalent to the 40-100-mesh fraction. The yield data are closely related to the *p*H changes, and lime at half rate was little inferior to the various liming materials at the full rate.

Another series of experiments compared commercial ground limestones of varying degrees of fineness (the one with 50-55 per cent passing the 100-mesh sieve being the nearest to the average commercial grade in Great Britain). The results for four experiments in 1945-47 are given in the following table.

**Table 3**

**Comparison of Results of Four Experiments Using Burnt Lime and Four Grades of Commercial Ground Limestone**

| | No Lime | CaO at Half Rate | CaO at Full Rate | $CaCO_3$ at Full Rate. (Percentage passing 100 Mesh) | | | |
|---|---|---|---|---|---|---|---|
| | | | | 20-25 | 30-40 | 50-55 | 100 |
| Average *p*H | 4.8 | 5.1 | 5.4 | 5.3 | 5.3 | 5.4 | 5.9 |
| Yields as percentage of general means .. | 66 | 99 | 106 | 106 | 106 | 107 | 110 |

As in the previous series of experiments, the very fine limestone had the biggest effect on both yield and *p*H, and the coarse ground limestones were slightly inferior to the fine limestone, but apparently as good as

ground burnt lime. The latter at half the lime-requirement rate gave yields not greatly less than lime at the full rate.

Other experiments compared waste limes, magnesian limes and other liming materials of different geological origin. The general conclusions were that when applied at equivalent rates in terms of neutralizing value, there was little to choose between them.

Summary. In a long-term liming experiment at Harper Adams College, lime applied at half, full and double the Hutchinson-McLennan lime requirement rate had very similar effects on the yields of acid-sensitive crops in the early years of the experiment. The subsequent changes in *p*H, exchangeable calcium, and the Hutchinson-McLennan lime requirements, indicated a delay of 4-5 years before applied lime had its maximum effect on these soil values, although effects on crop yields were immediate. The anomalous results often found in practice, where recently limed soils still show marked lime requirements, may be explained by this delay. Until lime applications have been absorbed into the soil complex, it is suggested, therefore, that the best method for assessing the lime requirement is the determination of the exchangeable calcium and free calcium carbonate, if present in small amounts. Other experiments carried out by Advisory Chemists also indicate that liming at half and full Hutchinson-McLennan rates gives yields only 10-15 per cent higher for the heavier dressings. Over a fairly wide range of liming, therefore, yields may be remarkably improved, and with a knowledge of all the various factors involved, almost any method used for estimating lime requirements can be adopted if recently limed soils are excluded. There is little difference between various forms of ground limestone, with a slight advantage for finer grinding.

J. E. W.
W. M. D.

**Field Plot Studies with Sawdust for Soil Improvement.** S. Dunn, L. P. Wolfe, Jnr., W. A. Macdonald and J. R. Baker. *Plant & Soil*, 1952, **4**, 164.

The use of sawdust for providing organic matter and as a mulch has provoked interest during the past few years. The earlier prejudice against its use has been overcome by demonstration that the process of decomposition in soil is similar to that of green manures, and can be facilitated by liberal dressings of nitrogen. Four years of experimental work in New Hampshire have given information on the relative effects of fresh and well-rotted coniferous sawdust and of farmyard manure on maize crops.

After ploughing, the $1\frac{1}{3}$-acre experimental site received $8\frac{1}{2}$ cwt. complete fertilizer (10 : 15 : 10), 3 cwt. magnesium sulphate and $13\frac{1}{2}$ cwt. hydrated lime. The original *p*H was 5.5. In a randomized block arrangement fresh sawdust was applied at 121.9 tons per acre and rotted sawdust at 130.6 tons per acre. This gave a layer 3 inches deep over the soil surface. The farmyard manure was applied at 90 tons per acre. All these materials were disced in.

Although over four years the plots treated with rotted sawdust gave the highest yields, followed by those with farmyard manure, and the yield of maize on the control plots and those receiving fresh sawdust was the same, no statistically significant differences were established between any of the treatments.

The effect of the organic materials on soil moisture conditions was good and buffered fluctuations in times of drought.

J. B. E. P.
W. M. D.

## HERBAGE

**Symbiotic Adaptation in Local Strains of Red Clover and Nodule Bacteria.** P. S. Nutman and Margaret P. Read. *Plant & Soil*, 1952, **4**, 57-75.

Local strains of red clover of Swedish and British origin were examined for evidence of adaptation to local strains of nodule bacteria. The symbiosis of local strains of plants inoculated with their homologous bacteria—that is, the bacteria isolated from the district of the parent plant material—was compared with the symbiosis of plants inoculated with heterologous bacteria—that is, bacteria from other districts. In addition, homologous symbiosis was compared with that of local strains of bacteria and heterologous plant material.

Within the Swedish material as a whole, there is local, mutual adaptation of plant to bacteria. The average effect is small, but it is considered to be of significance in the adaptation of these local strains to their environment. Within the British material there was no evidence of positive adaptation. The difference in the behaviour of the plants from the two countries may be the result of either longer periods of isolation of the local red clover strains, or to the much wider range of climatic conditions under which the Swedish strains have developed.

The data in respect to numbers of nodules formed support the view that adaptation tends to reduce nodule numbers, and is in agreement with the finding that, in general, more effective symbioses accompany sparse nodulation.

**Physiological Studies on Nodule Formation**

I. The Relation between Nodulation and Lateral Root Formation in Red Clover. P. S. Nutman. *Ann. Bot.*, 1948, N.S. **12,** 81-96.
II. The Influence of Delayed Inoculation on the Rates of Nodulation in Red Clover. P. S. Nutman. *ibid.*, 1949, N.S. **13,** 261-83.
III. Experiments on the Excision of Root-tips and Nodules. P. S. Nutman. *ibid.*, 1952, N.S. **16,** 79-101.

The roots of leguminous plants may be exposed to a mass infection by nodule bacteria, but the number of nodules formed is small compared with the number of points at which root hairs are infected. The question arises as to the circumstances which determine the course of

development between infection and nodule formation. The results of this series of experiments support the view that the possible nodule sites are also those for lateral roots. The total of lateral roots and nodules were almost the same whether the plants were inoculated with effective or ineffective strains of bacteria. The latter gave rise to a larger number of nodules and a smaller number of lateral roots than the effective strains. Seedlings, whether inoculated by effective or ineffective strains, possessed fewer lateral roots than uninoculated seedlings.

Red clover, grown under laboratory conditions and inoculated at sowing, produces nodules at the two and a half-leaf stage, or approximately fifteen days after sowing. The rate of nodule formation progressively falls with the age of the plant, but ineffective strains of bacteria continue to produce nodules at a faster rate and eventually produce a larger number than effective strains. When inoculation is delayed until after germination, nodules are produced more quickly and there is a reduction in the period between inoculation and nodule formation.

The general interpretation of the results was that bacteria penetrate the root and produce nodules only within those zones possessing root hairs, and at points of incipient meristematic activity which are the foci of lateral root formation. The actual development of nodules at these foci is conditioned by an inhibiting activity of the meristems of the lateral roots and nodules already present on the root. It is suggested that the meristematic tissue of ineffective nodules is ephemeral and produces less of the inhibiting substance. This would account for the fact that a larger number of nodules follows inoculation by ineffective strains.

That nodule formation is influenced by the production of an inhibitor in the growing points of root and nodule was examined in a study of the effect of cutting out these portions. It was found that, with effective strains of bacteria, excision of nodules or root tips was followed by a temporary increase in the rate of nodule formation, and the effect of nodule excision was greater than root-tip excision. When only the meristematic cup of the nodule was removed, stimulation of nodule production was equally pronounced—indicating that the terminal meristematic tissue was the source of the inhibiting substance.

T. E. W.

## CROP HUSBANDRY

### Field Beans

M. H. R. Soper has given an interim report of his investigations into the field bean crop in *Agriculture* (1952, **59,** 229-34) and has also published elsewhere some of the technical data upon which his conclusions are based (*J. agric. Sci.*, 1952, **42,** 335-46). In a preliminary survey in 1948 and 1949 it was found that 90 per cent of the bean crops followed a cereal, and nearly 40 per cent followed two cereals in succession. Further, half the crops that were grown after two cereals were receiving no assistance either from fertilizers or farmyard manure. Nearly 40 per cent of the fields had no dressing at all. The survey showed that an early sowing (first fortnight in October) gave a far higher plant population than a later sowing (November), and a markedly significant increase in the number of pods per acre. In detailed experiments, early sowing gave no advantage in 1949 (when the winter was exceptionally mild), but in 1950 there was a significant difference in yield of some 3½ cwt. per acre in favour of the early October sowing. In both years a high rate of seeding (4 bushels per acre) gave very definite increases in yield compared with a 2-bushel seed rate at both sowing dates : the average differences were about 4 cwt. per acre. Soper also found that row width is unimportant, provided the density per unit area is uniform : but for dirty fields, 21-inch rows are to be recommended because they facilitate cleaning. Deep drilling (3 inches) is essential, particularly on puffy soils or hollow seedbeds. The soil must not be allowed to fall away from the plant in a wet winter, as the stem tissue is very easily damaged by low temperatures.

If oats are grown with the bean crop, it seems unlikely that the yield of starch equivalent per acre will be increased, whereas the yield of crude protein is likely to be quite seriously reduced. On the other hand, the addition of a bushel of beans to a crop of oats may add some valuable crude protein to the yield without materially affecting the total starch equivalent.

The general conclusion is that the bean crop on many farms is not being given a fair chance because it is often planted on rather impoverished and foul land, and is not properly manured. The suggestion is made that if growers would pay the same amount of attention to the crop as they would pay to a crop of sugar beet or potatoes, there would be far less dissatisfaction with low yields.

D. A. Boyd has also published an account of the Rothamsted experiments on field beans (*J.R. agric. Soc.*, 1952, **113,** 55-76). He first of all mentions the erratic yields of the bean crop and briefly reviews the factors which affect yield. He then details the Rothamsted factorial experiments with farmyard manure and fertilizers, and makes reference to trials at other centres ; these are illuminating if only for the reason that they show how very scanty is our accurate information about this crop. Boyd's conclusions about manuring are that on bean-growing farms part of the available supplies of farmyard manure could be used

more profitably on beans than on cereals or grass. If dung is not available, the main need is for potash : the most profitable dressing on average soils at present prices is about 1½ cwt. per acre of 50 per cent muriate of potash. It is difficult to justify more than a very small dressing (about 1 cwt. per acre) of superphosphate. It is wasteful to use nitrogen on winter beans, and nitrogen is of doubtful value for the spring crop.

As regards rates of seeding, Boyd's views agree with those of Soper, mentioned above, in that generous seeding pays. Up to 3 cwt. of seed (say 5 bushels) has proved to be profitable ; sowing in early October has given better yields than sowing in late October or November. Increased seeding only partially compensated for late sowing. No difference was found between broadcasting before ploughing, and dropping the seed in the furrow by an attachment on the plough beam.

### Borax for Weed Control

Experiments to test the possibility of using borax to control weeds in sugar beet crops have been described by J. C. Kandy, K. C. Berger and E. Truog (*Agron. J.*, 1952, **44**, 409-11). The soil used was typical beet land in Wisconsin, and the beet crop was properly fertilized. Borax was applied in two ways : either at each side of and slightly below the seed, or in a 4-inch-wide band on the soil surface over the seed. The quantity used varied from 20 to 80 lb. per acre, and the trials extended over the years 1948, 1949 and 1950. The summary states that the application of borax at the rate of 40 lb. per acre by either method was very effective as a weed control measure. The soil surface application of borax over the seed generally gave a better control of the weeds in the row than the side-of-seed method of application, giving a decrease of as much as 65 per cent in the numbers of weeds. There were slight decreases in yield from the higher application rates (60, 70 and 80 lb. per acre). In no instance was the stand of beet affected by the rate or method of applying the borax. In most cases, the weeds remaining after 40 lb. borax had been applied by either method were stunted and, as a result, hand-weeding was generally unnecessary. Unfortunately, no mention is made of the species of weeds present in the experimental fields. All the borax applications were accompanied by 200 lb. of 3:11:12 in the row and 800 lb. of 6:6:18 applied broadcast per acre. The paper makes no mention of possible residual toxicity to following boron-sensitive crops, but refers in the literature review to the fact that potatoes can suffer from boron toxicity.

### Chemical Weed Control

In the March, 1952 issue of the *Journal of the Institute of Corn and Agricultural Merchants* (**3**, No. 4) there are six articles dealing with various aspects of weed control by chemicals : " The Safe Handling of Poisonous Substances Used as Weedkillers " by P. Lesley Bidstrup, " Weed Control in Turf with Special Reference to Selective Weedkillers " by R. B. Dawson, " General Principles, Care and Maintenance of Spraying Machines " by G. Fear, " Weed Control in Cereals " by F. P. Cattle,

" Weed Control in Linseed and Flax " by F. B. Cattle, and " Chemical Control of Weeds in Peas and Lucerne " by C. V. Dadd. These articles are very short but can be recommended as a summary of the present position.

### BHC Taint in Potatoes

Since the introduction of benzene hexachloride (BHC) as a means of controlling wireworm by soil treatment, complaints have been made that the chemical imparts a taint to potatoes and some other crops. H. R. Jameson and C. C. Tanner (*J. Sci. Fd Agric.*, 1951, **2**, 171-5) reported that the degree of taint in potatoes, grown on land into which crude benzene hexachloride has been worked by normal cultivation methods, depends upon the amount of crude BHC applied per acre, and the time elapsing after application. Potatoes grown in land treated with 4 lb. crude BHC (containing 13 per cent gamma-isomer) per acre for the control of wireworms, are likely to be tainted if they are planted within 18 months of the date of soil treatment; if planting takes place three years after soil treatment, the crop should be free from taint. It was noticed that four typical potato varieties susceptible to taint are (in increasing order) King Edward, Arran Banner, Majestic, and Eclipse. When BHC is applied by surface dusting and not worked into the soil the results are not the same. BHC at rates up to 6 lb. per acre has been widely used to control flea beetle in brassicas without tainting following potato crops.

H. R. Jameson and F. C. Peacock (*ibid*, 1952, **3**, 78-82) later suggested that if the application of BHC-13 to the soil does not exceed $\frac{1}{4}$ lb. per acre annually, the risk of tainting potatoes growing on loam soil seems slight. Surface application at rather higher rates may also be safe. In a more recent paper, H. R. Jameson and F. C. Peacock (*ibid*, 1953, **4**, 102-4) report that, so far as the tainting of potatoes is concerned, the highly purified gamma-isomer of BHC behaves in just the same way as crude BHC (13 per cent gamma BHC). They conclude that up to about $\frac{1}{2}$ lb. of either grade can be applied per acre, just before a potato crop is planted, without risk of subsequent taint, and that similar freedom from taint may be expected with 2 lb. per acre applied twelve months before planting.

G. E. F.
D. H. R.

## MACHINERY

### Work Simplification Studies in France

The Bulletins issued by the French Institut d'Organisation Scientifique Du Travail en Agriculture, Paris (I.O.S.T.A.) give an account of work done by this Institute, which has a small staff of agricultural engineers who specialize in studies of farm work organization. Many of their investigations are carried out on farms belonging to members of the

Institute, but use is also made of the results of studies published in other countries.

*I.O.S.T.A. Bulletin No.* 33 (May-June 1952) deals, on p. 63, with the handling of grain from combine harvesters. The first part concerns only handling the grain in sacks, and distinguishes between the following methods :

*Methods which enable the sacks to be dropped or transferred with the combine in motion.*

1. Dropping the sacks to the ground and picking them up again.
2. Passing the sacks direct to a trailer alongside, one at a time.
3. Passing the sacks to a trailer alongside in batches of 6—8 by means of a hinged platform.

*Methods which necessitate the combine stopping for the sacks to be transferred.*

4. Use of a big platform on the combine, at trailer level, and transfer to a vehicle alongside.
5. Sacking-off on a high-level platform and delivering the sacks to a trailer by means of a chute.
6. Delivering the sacks to a trailer towed behind the combine.
7. Sacking-off on a trailer from a combine equipped for bulk handling.

The results given for these methods were briefly as follows :

**Working Time on each of Seven Methods**
(*Man/Minutes per Hectare**)

| Method | Combining and Getting the Grain Sacked-up | Sack Handling from Field to Farm | Total of Two Operations |
|---|---|---|---|
| 1 | 240 | 150 | 390 |
| 2 | 240 | 285 | 525 |
| 3 | 240 | 150 | 390 |
| 4 | 295 | 295 | 590 |
| 5 | 420 | 140 | 560 |
| 6 | 250 | 250 | 500 |
| 7 | 155 | 310 | 465 |

Some of these results may be considered surprising, and the report does not make clear how many farms and machines were included, but the study serves to emphasize the fact that a simple distinction between handling grain in sacks and handling in bulk is inadequate. There are many methods of handling the grain both in sacks and in bulk, and there can be a greater difference between two methods of sack handling than between one of these and a particular method of handling in bulk.

The bulletin goes on to analyse the results obtained from several methods of picking up sacks by hand, and by the use of various kinds

*Hectare = 2.471 acres

of mechanical loaders. A point brought out is that many of the mechanized methods save human effort but do not save time.

Other I.O.S.T.A. publications of interest include *Bulletin No.* 28 (July-August 1951) which deals, on p. 96, with field work in haymaking during 1951—a difficult haymaking season; Publication No. 18 *Organisation du Travail de Recolte des Pommes de Terre*—a study of potato lifting; and Publication No. 20 (1951) *Organisation du Travail d'Ensilage des Fourrages Verts*—a comprehensive bulletin dealing with the mechanical details of silage-making.

C. C.

## FRUIT

### Efficiency in Handling and Packing Fruit

A number of Californian fruit-packing firms recently co-operated with the University of California and the United States Department of Agriculture in a long-range study of costs and efficiency in marketing fruit. The work began in 1949 and a series of papers describing its various aspects has now appeared.

The first of these papers [1] discusses the problem and the methods used. Costs were adjusted to represent uniform conditions with respect to wages, hours of operation, type of container and length of season. All calculations were thus based on a normal eight-hour day with average rates of operation. Fixed costs were based on estimates of current replacement values for buildings and equipment, and the assumption of thirty full packing days per season. All costs for packing were in relation to boxes containing 48 lb. net of pears.

The cost per box of packed fruit averaged about one dollar (approximately 7s.). Of this, labour costs amounted to roughly 30 per cent, operating and administrative costs to 10 per cent, and packing boxes and materials to 50 per cent. The costs of the different items varied as between packing-houses and suggest that even the best operated concerns could improve their efficiency in some operations, and that the worst were usually fairly efficient in some practices. It is, therefore, not possible to reduce costs by one overall adjustment, but only by change and adjustment of many individual operations.

*Grading Costs* are dealt with in the second part of the report [2], and it is shown that 95 per cent of these costs were in the form of wages paid to the grading gang. It is considered possible to reduce grading labour in a typical packing-house by about 25 per cent for pears and by more than 50 per cent for apples. Figures were obtained to show the effects of changes in the grading gang on the number of bushels of first-grade and sub-grade fruit sorted per hour, and as a result a graph was prepared showing the optimum size of gang per sorting table for different volumes of fruit. It is suggested that the first stage of reorganization should be the elimination of excess grading labour. The second stage should be the adjustment of daily working hours and the number of grading tables

in operation, to ensure that the hourly volume per table is as near the peak volume as possible. In apple-packing plants, a further reduction of costs (about 14 per cent) can be made by using a machine with which only fruits in certain grades have to be picked out by hand, other fruits going on a belt directly to the sizing machine. Further reductions may be possible in large plants by reorganizing the layout, a complex matter depending on the particular conditions in each case.

*Transport from the Field* is the subject of the third part [3]. If a low-loading tractor-trailer with two men was used to pick up the fruit in the orchard and carry it to the road, where it was transferred to a lorry for transport to the packing-house, it was found that the time taken was 75 man-minutes per 100 boxes, exclusive of travel time on the road. If the lorry came into the orchard and was loaded by a tractor fork-lift, which gathered up the boxes from under the trees, the orchard crew consisted of one man (loader-driver), and 54 man-minutes were required per 100 boxes. Bringing a low-loading lorry into the orchard and loading directly by a two-man crew further reduced the time to 46 man-minutes per 100 boxes. Finally, with low-loading, four-wheeled road trailers, coupled in threes and drawn by a tractor, the labour requirement was 32 man-minutes per 100 boxes, one man serving as both loader and driver.

While a change in equipment may result in a saving of labour, it is important to balance the increased cost of the equipment against this saving. For some growers, improving the present method may be more profitable than changing to a new method, and in this connection it is as well to consider the size of the load hauled per trip and the size of the loading gang in the orchard.

*Packing Labour.* The fourth part [4] suggests the discharge of inefficient packers and the selection of those who are above average. The elimination or reduction of delays and unproductive time caused by breakdowns, uneven flow of fruit, etc., is also important. The sizing equipment should be adjusted to level off peaks in size distribution, so that a larger proportion of the packers can work on the sizes where the volume flow is largest and most constant. The labour gang should be adjusted to the actual rates at which the fruit is being handled.

It was found that when the total hours of operation were low, the ordinary bin type of machine was cheaper than packing from the rotating tub type or direct from a conveyor belt, sizing by eye. At 150 hours per season, the bin and belt types were equal and cheaper than the tub, whereas at more than 200 hours, belt plants were cheapest and bin plants dearest, with tub plants intermediate.

*Types of Buildings.* A comparison of the costs of maintenance and replacement of a concrete-constructed and -floored packing-house for operation with fork-trucks, and those of a wooden-framed and -floored building where hand-trucks are used, is given in the fifth part [5]. The concrete building had the higher initial and replacement cost, but owing

to its longer life and lower fire risk, its annual cost was very similar to that of the wooden building.

*Internal Transport*, that is, the movement of the fruit and materials on the floor of the packing-house, is considered in the sixth part of the report [6 and 7]. This part of the process accounts for a good deal of the work involved in packing fruit. Hand-trucks, powered hand-trucks, fork-lift trucks, and various gravity and powered conveyors were all used. The individual load varied with the equipment, ranging from 5-6 full boxes or 14-21 empties with hand-trucks, to 30-42 full boxes or 72-96 empties with fork-trucks. Mechanization showed a four-fifths reduction in costs, from 16.1 per cent of total labour in a hand-truck plant, to 3.7 per cent in a fully-mechanized packing-house. The cost of equipment was, however, fifty times as high for fork-trucks as for hand-trucks.

For seasons shorter than 260 hours the savings due to fork-trucks are not great enough to balance the higher overheads, and hand-trucks are more economical, but for seasons longer than 260 hours fork-trucks show an advantage, and with 300 hours the total saving is appreciable. A further saving can be made by using a power-conveyor to take the packed boxes direct to the lorry ; this saving is especially important where hand-trucks are used.

Where the season lasts more than 500 hours, remodelling the reception bay so that fork-trucks can be fully used was shown to be advantageous.

A further point in this comparison of transport methods was the greater speed with which the grower's lorry could be unloaded when fork-truck equipment was used, and the fewer workers required. This may justify the use of fork-trucks where they might not be clearly justified on the basis of cost alone.

These papers contain illustrations and tables that are worthy of careful study by all who are interested in the efficient handling and marketing of fruit.

**References**

1. Studies on Efficiency in Fruit Marketing Practices. R. G. Bressler. *Calif. Agric.*, 1952, **6**, (6), 8-9, 12.
2. R. G. Bressler and B. C. French. *ibid.*, 1952, **6**, (7), 7-8, 10.
3. L. L. Sammet. *ibid.*, 1952, **6**, (8), 10-2.
4. B. C. French. *ibid.*, 1952, **6**, (9), 9-10.
5. L. L. Sammet and I. F. Davis. *ibid.*, 1952, **6**, (10), 10-2.
6. L. L. Sammet. *ibid.*, 1952, **6**, (11,) 11-2.
7. L. L. Sammet. *ibid.*, 1952, **6**, (12), 7-8, 11.

H. B. S. M.

## NUTRITION OF HORTICULTURAL CROPS

### Urea

Much has been written about the prospects of using urea as a source of nitrogen for growing crops. As this substance is easily soluble in water, its suitability as a nutrient spray has an immediate appeal to the orchardist. In America experimental work with a range of crops has contributed largely to our knowledge of the subject ; research in progress

in this country is mostly concerned with the value of urea sprays in orchards under grass, where there is a natural tendency for the trees to become short of nitrogen.

**The Principles underlying Foliage Applications of Urea for Nitrogen Fertilization of the McIntosh Apple.** E. G. Fisher. *Proc. Amer. Soc. hort. Sci.*, 1952, **59**, 91-8.

Experiments were conducted over a period of three years on twenty-year-old McIntosh apple trees maintained under grass. Three principles are outlined for the use of urea foliage sprays.

In orchards where applied nitrogen is required to maintain yields, foliage sprays of urea give yields comparable with, or greater than, equivalent amounts of urea applied to the soil. Three post-blossom sprays, using 5 lb. urea in 100 gallons of water, appeared to give optimum results. Trees receiving two pink-bud sprays had significantly better fruit colour than those having three post-blossom sprays.

The second principle stated concerns the time of spraying. It was found that post-blossom sprays gave a greater leaf nitrogen content than pre-blossom applications. If the spray was applied prior to the June drop, an increase in set and yield were most likely, although reduced yield might be expected in the following year.

Lastly, leaf sprays of urea were found to give quicker nitrogen responses than the same amounts of urea applied to the soil. Although the sprays gave better nitrogen responses, it is pointed out that the nitrogen levels of the leaf may drop more rapidly than those resulting from soil applications. Whilst urea sprays may give improved fruit set, yield and colour, drawbacks can occur if the set is heavy and nitrogen reserves are low. In such cases the trees produce small fruits, a decreased bud formation and a smaller increase in trunk diameter.

**Nitrogen Fertilization of Apple with Foliage Sprays of Urea. Progress Report.** C. Bould and J. Tolhurst. *Ann. Rep. Long Ashton Res. Sta.*, 1951, 49-53.

An experiment was carried out in 1950-51 in a commercial orchard of Laxton's Superb bush apple trees on Malling No. 1 rootstock. The trees were 11 years old, growing in a grass cover plus clover sward kept short by gang mowing. A 1 per cent urea spray (10 lb. urea in 100 gallons water) was used, adding Estol " H " as a wetting agent. Treatments consisted of one, two and three post-blossom sprays respectively, applied between the beginning of June and the first week in July.

During 1950 no visual differences in foliage or fruit colour between treatments were noticed. Although all the trees appeared to be low in nitrogen before spraying, the nitrogen status of the leaves increased throughout the summer, even on the control. Estimations of total leaf nitrogen showed no significant differences between treatments.

In 1951 the same treatments were repeated. Trees in the different treatments showed no visual differences in leaf colour, extension growth or fruit quality. No yield data were available. However, differences

in leaf nitrogen were found ; the greatest increase was produced by the petal-fall spray, later sprays having less effect. It was noticed that the effect of the first spray diminished as the season advanced.

The urea sprays caused no damage to foliage.

**Studies on the Nitrogen Nutrition of Tomatoes with Foliar Sprays.** J. Montelaro, C. B. Hall and F. S. Jameson. *Proc. Amer. Soc. hort. Sci.*, 1952, **59**, 361-5.

The sandy soils of Florida with their low exchange capacity, low organic matter and low mineral status, due to heavy leaching, offer potentially suitable conditions for using urea sprays. Experiments are described using urea sprays on tomatoes. Treatments consisted of applying urea sprays (2.5 lb. urea in 100 gallons of water) and equivalent soil applications.

It appears from the data that soil nitrogen is necessary for fast initial growth and that leaf applications of urea give no beneficial responses if sufficient nitrogen has been applied to the soil. No significant increases were found in total weight of tomatoes in the different treatments. When urea spray treatments were compared with side dressings of sodium nitrate, no differences could be detected in earliness of maturity or in yield.

It is evident from these trials that no benefits accrued from the use of urea sprays on tomatoes.

**" Die-Back " in Raspberries.** H. O. Askew, E. T. Chittenden and R. J. Monk. *J. hort. Sci.*, 1951, **26**, 268-84.

Raspberries grown on a sandy loam in the Nelson district of New Zealand showed, under certain conditions, a " die-back " of the fruiting canes. Field trials indicated that a deficiency of boron in the plant was the cause of the symptoms, and a correction of the disorder was effected by the application of borax to the soil. The article is amply illustrated with pictures of the differing phases of boron deficiency in the variety Red Antwerp.

The important stage of boron deficiency occurred during the first weeks from bud-burst. A large proportion of buds failed to open. Buds which only partially developed showed distorted leaves with long petioles. Leaves which did develop were mostly small, thin, deeply indented and appeared " feathery ". When the growing points failed, laterals developed. The new growth was generally free from any of the symptoms seen on the older fruiting canes. Symptoms were more marked in old-established gardens and also where the soil reaction showed a soil *p*H 7.0 due to the liberal application of lime.

The estimation of boron in soil and raspberry leaves indicated that if the water-soluble boron in the soil was low, the amount in the leaf was correspondingly low. There was also a marked correlation between the low boron content of the foliage and the presence of deficiency symptoms. Borax applied at the rate of ½ oz. per bush proved satisfactory in correcting symptoms.

Leaves from healthy fruiting canes contained 35 p.p.m. boron, whilst the amount increased to 50-60 p.p.m. in young growing canes. The application of ½ oz. borax per bush increased the boron content in young canes to 300 p.p.m. ; even so, there were no signs of boron toxicity. Newly-transplanted canes, however, showed toxicity symptoms using this amount of borax per bush.

It is pointed out that weather conditions have a marked influence on the appearance and severity of deficiency symptoms. Similarly, liming, where it raises the soil reaction to *p*H 7.0, changes the boron in the soil into a condition unavailable to the plant.

**The Effects of Some Acute Mineral Deficiencies on Perpetual-Flowering Carnations.** J. H. L. Messing and O. Owen. *Rep. exp. Res. Sta. Cheshunt*, 1951, 78-81.

Two varieties, white Maytime and Spectrum (cuttings rooted in November), were grown in sand culture, and deficiency symptoms of nitrogen, phosphorus, potassium, calcium, magnesium, sulphur and boron were investigated. The experiment was divided into two parts : the first (" early ") section had the nutrients withheld from May 1 ; the other (" later ") section received nutrients until August 15.

Nitrogen deficiency in the " early " plants was shown by retardation of growth and yellowing of leaves ; after the first week in June no growth took place. In the " later " series, loss of leaf colour did not occur until October. The death of the old leaves from the tips backwards was characteristic of this deficiency. Both varieties behaved similarly.

When phosphorus was omitted, plants were stunted and the flowers smaller. There were no characteristic symptoms.

Potash deficiency produced weak stems and poor blooms ; the flower stems collapsed and wilted without the buds opening. Characteristic symptoms were noted on the leaves during July. The bottom leaves died rapidly, whilst the middle leaves showed loss of colour or scorching at the tips, followed by necrotic spotting. No symptoms were observed in the " later " treatment.

The syndrome of calcium deficiency consisted chiefly of stem lesions, occurring from the tip downwards. The stem showed a progressive topple effect.

Magnesium deficiency produced a narrow necrotic band across the leaf blade near the base ; the leaves subsequently collapsed and a reddish-violet border developed around the necrotic band. Blooms, though early, were small and poor in quality.

A shortage of sulphur in the nutrient solution caused stiffness of stems and chlorosis of growing points, followed by the whole plant becoming bright grassy green. Flowers were late and small, although of good texture and shape.

Boron deficiency in the " early " series showed tip scorch of young leaves followed, at the end of July, by death of the growing points. Lateral growths succeeded this stage and the plants became bushy.

In the " later " treatment, stiffening of the flower stems occurred in September. The outermost petals were distorted and transparent, and young shoots and buds quickly died.

W. P.

## VEGETABLE CROPS

**Vegetative Propagation of Cabbage and Allied Vegetables.** C. North. *Emp. J. exp. Agric.*, 1952, **20**, 43-6.

The breeding and maintenance of good strains of brassicas presents a most difficult problem to the vegetable seed industry. At present, desirable strains are raised and maintained almost entirely by mass selection. A satisfactory technique of vegetative propagation would assist the plant breeder and seed producer in several ways.

It is desirable to select stock seed plants under growing conditions similar to those which the market crop will encounter, but this may make it difficult to obtain seed from the selected plants, e.g., Italian types of broccoli selected in October and November often die during the winter without setting seed. Vegetative propagation would enable clones of autumn-selected plants to be planted out the following spring for seed production. It could also be used to prove a selected plant under a variety of conditions.

Periodic re-selection almost inevitably leads to a change in the characteristics of a strain. Vegetative propagation would enable a nucleus of stock plants to be maintained, from which plants could be taken for seed production as required.

The author describes three methods which have been used at the N.I.A.B. for vegetative propagation of brassicas. Brussels sprouts were maintained in the vegetative phase by transferring the plants from the field to a greenhouse kept at a temperature of above 60° F. During the winter, the " buttons " were removed so as to leave short stumps. Shoots growing on these stumps could be rooted, but more plants were obtained by waiting until the shoots produced leaves about 1-2 inches long, and then taking leaf cuttings. A similar method was used for cabbage.

Vegetative propagation of broccoli, sprouts and marrowstem kale was carried out using root cuttings. Carefully washed portions of roots were planted upright in sterilized sand, and kept at 60-70° F. After six to eight weeks the adventitious shoots were removed and struck as cuttings.

Pieces of broccoli curd, each with a portion of leaf attached, were induced to produce roots by hormone treatment. Adventitious buds arising at the base of the curds provided a source of cuttings.

**The Influence of Depth of Transplanting on Size and Shape of Head of Lettuce.** M. E. Marvel and J. R. Havis. *Proc. Amer. Soc. hort. Sci.*, 1952, **59**, 372-6.

Seedlings of Imperial 44 lettuce were planted out at three depths. At the shallow depth, the plants were placed so that the hypocotyl was

above soil level, but the roots were completely covered. For medium depth, the plants were set so that the oldest true leaves were barely above soil level. For deep transplanting, the plants were set so that the soil covered the base parts of the outside leaves. The terminal growing point was then just above soil level.

At harvest, weight of the individual heads did not differ significantly between treatments, but heads from the shallow transplanting treatments were significantly larger and less firm than the others. The heads from shallow planting were spherical in shape, while those from deep planting were markedly conical.

E. J. W.

---

## DAIRY HUSBANDRY

### Milk Replacement for Calves

Most of the recent work on the subject of milk-replacement foods for young calves has been carried out in the United States, where, in some areas, the margin between the cost of liquid milk and the replacement foods is large, and where the application of antibiotics to the feeding of calves has received much greater attention than elsewhere. In that country, the term " calf starter " is usually used for the concentrate mixture offered dry for the first time at two or three weeks old. The composition of these mixtures is similar to those used in this country for the same purpose, except for a greater use of maize products, the inclusion of a small proportion of milk products, and the addition of a number of supplements to take care of mineral and vitamin requirements. Many of the latter are covered in the United Kingdom by the inclusion of 5 per cent fishmeal, and the use of cod liver oil.

The interesting recent development in the United States has been the evaluation and commercial use of mixtures which can replace the liquid whole milk in the calf's diet. The objective is a much more complete replacement of liquid whole milk than is normally practised, even with the better type of proprietary calf gruels in this country. Thus a long series of feeding trials at the Pennsylvania Agricultural Experiment Station (*J. Dairy Sci.*, 1949, **32,** 986 ; 1950, **33,** 809 ; 1952, **35,** 675) has shown that mixtures can be made which, when mixed with water at 100° F., will give growth comparable with that produced from the feeding of whole milk, without, under the conditions of the trials, much indigestion or scouring. No more than two or three gallons of whole liquid milk was used after the fourth day of life. Most of the milk-replacement mixtures used in these trials contained dried skim milk and dried whey up to 60 or 70 per cent of the dry mixture : those with less than 40 per cent of dried milk products usually gave less satisfactory results. Several of the mixtures, however, consisted of feedingstuffs that are either available, or obtainable in a different form in the United Kingdom,

and, in spite of the high price of dried milk products, would, during winter, form a much cheaper source of nutrients than liquid whole milk.

It has frequently been suggested that the prospect of greater use of milk-replacement foods has been improved by the availability of antibiotics, both for calves and pigs, in the United States.

There have been a number of trials recently which indicate that feeding small amounts of aureomycin, or products containing aureomycin, can improve growth rate and also reduce the incidence of scours in young calves (*J. Anim. Sci.*, 1950, **9,** 646 ; 1950, **9,** 666 ; 1951, **10,** 1039, 1050, 1057 and 1065 ; *J. Dairy Sci.*, 1951, **34,** 500 ; *Proc. Soc. exp. Biol. Med.*, 1950, **75,** 531). In some of these trials the beneficial effect on growth disappeared as the calves grew, and there is a report of a detrimental effect on digestion in older cattle (*J. Anim. Sci.*, 1950, **9,** 647). There is, so far, little reported evidence on the effect of penicillin on the growth of young calves. Knodt and Bloom (*J. Dairy Sci.*, 1952, **35,** 675) report one trial in which this antibiotic significantly depressed growth rate.

It seems, therefore, that with an improved knowledge of calf nutrition, milk-replacement mixtures may, in future, be used to reduce substantially the cost of calf rearing, but it is too early to judge if this development will be hastened by the use of antibiotics. In the trials noted above, no attempt was made to replace the colostrum. The protection given to calves during the first few days of life by the antibodies in the dam's colostrum is now generally recognized. In this connection, Jacobsen *et al.* (*J. Dairy Sci.*, 1951, **34,** 905) carried out a trial in which the whole milk was replaced by colostrum, previously stored frozen, for calves from three to sixty days old. While the rate of growth and incidence of scour was about the same as in comparable calves fed on whole milk during this period, there was evidence of lower mortality in the colostrum-fed calves.

**Dairy Farming in New Zealand**

In discussing the progress of British dairy farming, comparison with New Zealand is by no means uncommon. Superficially, this seems justified since human and cattle populations in the two countries are clearly comparable, while the climate and topography show certain notable similarities. Output per man and output per acre on a New Zealand dairy farm are, however, often much higher than in Britain. The precise reasons for this are sometimes obscure, particularly to British agriculturists, few of whom can hope to see New Zealand conditions at first hand. The report of the delegation from the Milk Marketing Board (*A Report on Dairying Conditions in New Zealand and Australia, submitted to the Milk Marketing Board by a Delegation of the Board*, January, 1953), who visited New Zealand and Australia in September, October and November 1952, does much to explain the reasons for the remarkable output of man and land in New Zealand. It is evident that the New Zealand dairying areas are blessed with a climate almost ideal for growing grass, not only for three or four months in the year as in

many parts of Britain, but often for as much as ten months out of the twelve. The absence of winter housing, the elimination of all dung handling, the ability to arrange nearly all calving to coincide with the beginning of the main grass flush, and, above all, the abundant supply of high quality sward as a raw material for nearly all the milk produced, are factors that do not follow automatically in Britain, even under the best management. On the other hand, the report should stimulate much thought as to the principles underlying milk production from New Zealand pasture and also of the labour-saving methods which are encouraged by extensive use of " family " labour.

The deputation were impressed by the concept of a chain of events beginning with clover stimulation by liberal use of phosphates, followed by vigorous growth of grass due to nitrogen fixation by the clovers, followed in turn by greater dung and urine production on the sward and a further spiral upwards in herbage and, hence, in milk production. Their comment that " a farming system is surely approaching the ideal where higher output is gained, not at the expense but to the advantage of soil fertility," merits very careful consideration in relation to British dairy farming. The potential of clover and other legumes in building up sward production may be much lower in Britain but it is still sufficient to be of great economic importance. It is reasonable to suppose that the liberal use of phosphates (and in some areas, lime and potash) coupled with careful return of all dung and urine to the land from which it is produced, could have the same effect, although in smaller degree, in Britain. This fact is, unfortunately, often hidden by the harsh complications of long winter feeding and housing. With improvement in grassland management it may, however, become more apparent, and the Milk Marketing Board report should help to focus attention on this important matter.

**Milk Production**

Another report from the Milk Marketing Board (*Milk Marketing Board. Report of the Production Division.* No. 3, 1952) gives further valuable data on the progress of milk production in England and Wales. Much of the report is concerned with the development of artificial insemination. This is perhaps to be expected, since in a period of about eight years the proportion of cattle inseminated has grown from a small fraction of one per cent to about one-third of the dairy cattle population.

A number of specific investigations are reported. One of these, of particular importance to those interested in milk recording, is a study of the yields of groups of herds in 1942-43, compared with yields of the same herds in 1950-51. The investigation was limited to herds that have been recorded continuously during the period, and the data are set out in breeds and original yield groups. The improvement in yield is, of course, greatest in the herds in the low yielding groups in 1942-43, but some improvement is shown at all levels of production in all breeds except in the very highest yield groups. The data provide more evidence of the great potential for improvement in yield in nearly all herds.

Another study which is of importance to all dairy farmers is the investigation of the effect of age of first calving on yield. Data have been given in previous reports concerning the effect on the first two or three lactations. In the current report the mean yields for 44 per cent of the animals for the first four lactations combined are presented. Although the animals calving for the first time at two years old or a little over, gave, in general, a little less milk than the animals calving for the first time at about three years, the differences for the first four lactations combined were very small and certainly would not be expected to cover the combined cost of keeping the heifer for an extra year. Thus the study gives further evidence of the advantage of earlier calving, but with a warning that this may not be the case where a lower standard of feeding and management applies.

A. S. F.

## ENTOMOLOGY

**An Apparent Natural Transfer of the Bulb or Stem Nematode from Clover to the Strawberry Plant.** W. D. Courtney. *Phytopathology*, 1936, **26**, 607-9.

Though this paper has only recently been noticed, it is of great interest at this time. An instance is described of a natural transfer of the Stem eelworm (*Ditylenchus dipsaci*) from red clover to Marshall strawberries in the Pacific north-west of America. Clover known to be infested was grown in the field prior to the strawberries ; the latter soon developed the typical symptoms of Stem eelworm attack, and the eelworm was found to be present in the plants in large numbers. The same stock of strawberries grown elsewhere was found to be clear. Narcissus plants next to the strawberries were unattacked.

As previously noted in these abstracts, Stem eelworms of the oat strain, the narcissus strain and the clover strain have been reported as attacking strawberries, though it is known that these three strains are not able to interchange between their host plants, namely, narcissus, clover and oats, though they are evidently all able to attack strawberry plants.

**Stability of Formaldehyde Solutions used in Bulb Treatments.** V. L. Miller, W. D. Courtney and B. L. Anderson. *Phytopathology*, 1950, **40**, 627-31.

This is a useful paper since it deals with a question which has often been asked by bulb growers—whether any change occurs in the formaldehyde concentration of solutions used in hot-water baths for the treatment of bulbs? It gives a full account of the methods for investigating this matter and shows that there was generally an increase of up to 10 per cent of the original concentration in the bath water during eight heating periods without bulbs present. This increase in concentration was due to evaporation. When bulbs were present, and consequent losses of water due to drip and other factors were made up by adding formaldehyde

solution of the original strength, the original concentration was maintained.

It was noted, however, that where large baths were operated by steam in such a way that live steam was blown into the water, either during treatments or for preheating, the concentration of the formaldehyde solution was from 81 to 67 per cent of the original concentration in from four to seven heating periods ; this was believed to be mainly due to dilution of the solution with the condensed steam from heating operations.

**Symphylid Damage to Tomatoes.** L. N. Staniland and L. E. W. Stone. *Plant Path.*, 1952, **1,** 87-8.

Many cases of trouble with " root-death " of tomatoes have proved to be due not to primary attack by soil fungi but to attacks on the young plants in the spring. The symphylids feed on the root hairs, and the absence of these hairs was found to be a useful diagnostic symptom of such an infestation. Various secondary fungi later invade the roots. Tomatoes have been attacked in the open as well as under glass.

Experiments carried out on the control of the symphylids are described. The best method of control consisted of ball watering the young plants with parathion. This gave a complete and rapid kill with no hardening of the plants, and the root growth was outstandingly better than with any other treatments. The parathion was used at the rate of 1 fl. oz. of the 20 per cent concentrate to 10 gallons of water. The quantity for each plant was one pint.

It is suggested that extra seedlings should be planted at intervals between the rows when setting out the houses. A few of these plants can be lifted daily and tested for symphylids by washing off the soil in a bucket of water ; the symphylids will float to the surface and can easily be seen. When the symphylids have obviously collected round the plants in numbers (which takes from 3 to 5 days) parathion can be applied. A shallow depression round each plant, when setting out, is a help in securing local penetration of the treatment.

**Further Observations on the Biology of the Cabbage Root Fly *(Erioischia brassicae).*** M. Miles. *Ann. appl. Biol.*, 1952, **39,** 385-91.

A number of interesting observations on the egg-laying habits of this pest are included in this paper. Peak periods of egg-laying in 1951 occurred in late June and early July, in mid-August, and in the first half of October. Later observations showed that there is a very heavy mortality rate for this pest in the immature stages.

Some tests with tar-oil winter wash, used at a strength of 1¼ per cent, showed that it killed Cabbage Root fly eggs and also acted as a deterrent to egg-laying females for about a week. BHC was not found to have any ovicidal effect, but was toxic to the larvae.

**Soil Sampling for Wheat Blossom Midges.** W. H. Golightly. *Ann. appl. Biol.*, 1952, **39,** 379-84.

A method of assessing the population of Wheat Blossom midges by recovery of the cocoons containing larvae from the soil is described.

Pupae can also be recovered from the soil, and the emergence of midges from these pupae can be followed, so making it possible to estimate the number of midges that will emerge. Progress has thus been made towards predicting outbreaks of these midges. The cocoons of the midges can remain viable in the soil for a number of years. For example, 150,000 cocoons per acre were recovered in February 1951 from a field which had not had a wheat crop since 1944 ; and 50,000 per acre were found in a field last under wheat in 1947.

**Transmission of Reversion of Black Currants.** A. M. Massee. *Ann. Rep. East Malling Res. Sta.*, 1951-52, 162-5.

For some years it was strongly suspected that the Blackcurrant Gall mite (*Phytoptus ribis*)—the cause of " big bud "—was a vector of reversion disease of black currants. This more recent experiment would seem to settle the matter. Each of twenty-four normal bushes, artificially infected with gall mites obtained from reverted bushes, developed the symptoms of reversion in three years or sooner. Untreated control bushes remained apparently normal. Similar experiments using Currant Capsid bug and four species of currant aphids all gave negative results.

**Supplementary Measures for the Control of Codling Moth *(Cydia pomonella).*** J. R. Groves. *Ann. Rep. East Malling Res. Sta.*, 1951-52, 174-8.

This paper draws attention to the danger arising from the hibernation of Codling Moth larvae in packing sheds and in apple boxes ; these form points of infection from which infestation can spread to the orchard.

In addition to the usual method of control of this pest in the orchard by means of lead arsenate sprays, the inside of the packing shed and all stacks of empty apple boxes should be sprayed with DDT (5 lb. of 20 per cent wettable powder per 100 gallons of water) during the last week in May ; special care should be taken to spray the windows of the shed. From then to the end of July, the shed should be kept shut up as much as possible. Infested fruit should always be disposed of at the earliest opportunity.

L. N. S.

## VIROLOGY

**The Spread of Beet Yellows and Beet Mosaic Viruses in the Sugar Beet Crop.** M. Watson, A. R. Hull, J. W. Blencowe and B. M. G. Hamlyn. *Ann. appl. Biol.*, 1951, **38**, 743.

A survey of aphids and virus diseases of sugar beet crops in eastern England was made between 1940 and 1948. Prior to 1943 the observations were made on fertilizer experiments ; from 1943 onwards they were made on commercial fields selected for position in relation to beet and mangold seed crops. The incidence of Beet Yellows increased with increasing numbers of *Myzus persicae*, but not of *Aphis fabae*. The relation with *M. persicae* was sufficiently close to suggest that it is the

most important, and possibly the *only* important, vector of Beet Yellows virus. Beet Mosaic virus also increased with increasing numbers of *M. persicae*, but the relation was not close enough to exclude the possibility of other vectors. Numbers of *A. fabae* on sugar beet were slightly, but consistently, depressed by the use of salt as a fertilizer. Other fertilizers had variable effects. Neither aphids nor virus are likely to be greatly affected by fertilizers.

Beet Yellows is most prevalent in areas where seed crops are grown, but, within these areas, nearness to individual seed crops did not appear to increase its incidence. *M. persicae* were more numerous on sugar beet in seed-crop areas than elsewhere, and this alone might account for the prevalence of yellows. Beet Mosaic virus is more closely associated with seed crops than is Beet Yellows ; it is most prevalent near to seed crops within the seed-crop areas.

**Some Properties of Broad Bean Mottle Virus.** F. C. Bawden, R. P. Chaudhuri and B. Kassanis. *Ann. appl. Biol.*, 1951, **38**, 774.

A severe disease affecting many plants in a crop of broad beans was found to be caused by a previously undescribed virus, provisionally named Broad Bean Mottle virus. The distribution of diseased plants suggested spread by a vector, but none of the six insects tested transmitted it. The virus was transmitted to several species of leguminous plants by mechanical inoculation of sap ; infectivity for some hosts seemed to be increased by propagation in them.

The virus has an unusual combination of properties. Its thermal inactivation point is about 95° C., whereas sap becomes non-infective within three weeks at room temperature. The infection end-point of broad bean sap is 1/1,000, only a little higher than the precipitation titre with specific antiserum. Precipitation of antiserum occurs over a smaller range of antigen/antibody ratios than with other viruses previously studied, possibly because of its greater solubility. It is not precipitated with $(NH_4)_2SO_4$ until the salt concentration exceeds 75 per cent saturation. A specific nucleo-protein, containing nucleic acid of the ribose type, can be isolated from infective broad bean sap in yields up to 2g./l. Purified preparations, made by salt precipitation and ultracentrifugation, contain uniform spherical particles approximately 17 mμ in diameter. It is suggested that much of this nucleo-protein is non-infective, but may otherwise resemble infective particles.

**Studies in *Rubus* Virus Diseases : I. A Latent Virus of Norfolk Giant Raspberry.** C. H. Cadman. *Ann. appl. Biol.*, 1951, **38**, 801.

A selection of Norfolk Giant raspberry was infected with a virus transmissible by *Amphorophora rubi* Kalt. after short feeding periods on infected plants ; the virus persisted for at least 18½ hours in the aphid. This virus is identified with one which is carried without symptoms by Norfolk Giant and Baumforth's Seedling B. It causes necrosis on *Rubus henryi*, and mosaic symptoms on *R. saxatilis*, American black raspberry,

*R. occidentalis* (var. Cumberland) and the red raspberry varieties Chartham, Malling Landmark, and St. Walfried. The virus is present in some commercial stocks of Baumforth's Seeding B., Burnetholme Seedling, and the Malling varieties Enterprise, Notable and Promise. The name Raspberry Leaf Mottle is proposed.

**Enige ziekten en plagen in cultuurgewassen in 1950 en hun bestrijding.** *Versl. PlZiekt. Dienst, Wageningen*, **118**, 1951.

Observations on virus diseases of dahlias, begun in Holland in 1948, have been continued. Over 78 per cent of 600 plants, involving 98 varieties suspected of virus infection, showed symptoms of Dahlia Mosaic, while only 2 per cent showed symptoms of Tomato Spotted Wilt. Dahlia Mosaic appeared rather late in the season, in September to October, and Spotted Wilt rather early, up to September. Diseased plants produced fewer flowers than normal, and some varieties showed colour-breaking. Tests showed that virus transmission over distances exceeding forty miles was unlikely.

**Sur une maladie à virus du Cresson** (*Nasturtium officinale*). G. Roland. *Parasitica*, 1952, **8**, 1-3.

A virus disease of watercress has been recorded in Belgium. The symptoms consisted of a yellow mosaic with a tendency to ring formation ; the insect vector was shown to be the aphid, *Myzus persicae*. The most common virus disease of watercress in the British Isles is caused by the virus of Cabbage Black Ringspot. However, the Belgian disease differs from this in the fact that the virus is not transmissible to tobacco or *Nicotiana glutinosa*, which are susceptible to infection by the Cabbage Black Ringspot virus. In addition, it is persistent in the aphid—which the latter virus is not.

**Control of Cauliflower Mosaic Virus.** J. G. Jenkinson and G. D. Glynne Jones. *Nature, Lond.*, 1951, **168**, 336.

Experiments on the control of Cauliflower Mosaic were carried out at Seale Hayne College, Devon. The varieties Extra Early, A.6 and B.1 were used and grown in two different seedbeds, one adjacent to an infected broccoli crop and one half a mile away from any crop of Brassicae. The experiments emphasized the importance of seedbed infection, which can be the main cause of reduced yield. There was no difference in varietal susceptibility, although the plants grown in the isolated seedbed gave an average total yield of 49.5 lb. per plot, compared with 36 lb. for those grown in the non-isolated seedbed.

Application of a systemic insecticide gave good control of the aphid vector *Brevicoryne brassicae* but failed to reduce virus transmission.

**Lettuce Mosaic in the Field.** L. Broadbent. *Agriculture*, 1951, **57**, 578.

In this account of the spread and control of Lettuce Mosaic, the importance of seed transmission of the virus is emphasized. Up to 15 per cent of the viable seed produced by infected lettuce plants may give rise to mosaic plants. From observation of fields in Buckinghamshire,

it was found that crops with 1 per cent seed-borne infection yielded at harvest time from 3 to 40 per cent infected plants, depending on the number of aphids. The virus can be carried from infected winter lettuce to early spring crops, and from those to early summer crops. Two species of aphids, *Myzus persicae* and *Macrosiphum euphorbiae*, are vectors of the Lettuce Mosaic virus.

Control measures recommended consist of the use of virus-free seed, the isolation from other lettuce of the overwintering frames, seedbeds and winter crops. Transplants should be dipped in a nicotine solution, and an aphicide may be applied during late November. It is advisable to grow the lettuce crops in large, widely-separated blocks; diseased plants and crop residues should be destroyed.

**Retention of Tobacco Mosaic Virus in Tomato Seeds.** S. P. Raychaudhuri. *Phytopathology*, 1952, **42**, 114.

Seeds of tomatoes with symptoms of internal browning obtained from two localities in New Jersey were germinated in the greenhouse at weekly intervals, and extracts from the resultant seedlings tested on *Nicotiana glutinosa* for the presence of Tobacco Mosaic virus. Only seedlings raised from seed stored for a week were found to be infected by strains of the virus associated with internal browning. However, the ordinary strain of Tobacco Mosaic virus was retained for twenty-seven days by stored seeds from tomatoes infected by internal browning. Moreover, dry seeds from tomatoes infected by internal browning retained a small quantity of the virus externally for at least a fortnight.

K. M. S.

# PROVINCIAL NOTE

## SOME OBSERVATIONS ON THE OCCURRENCE AND CORRECTION OF NUTRIENT DEFICIENCIES IN FRUIT TREES AND BUSHES

F. A. Roach

*National Agricultural Advisory Service, South-Western Province*

Since 1950 some eight cases of copper deficiency have been found in fruit trees in the South-Western Province : two of these were in Devon and six in Wiltshire. The two cases in Devon were both in nurseries from which trees have been sold over a period of years—in one case for over 80 years—and the deficiencies seem to be the result of exhaustion of copper supplies in the soil. In Wiltshire all the cases occurred on

soils of the Lower Greensand, and again they appear to be straightforward deficiencies of the element not associated, as in some other countries, with a particular *p*H or the presence of a large amount of organic matter.

Wherever copper deficiency has been found, symptoms have first been observed in young pear trees, and the pear certainly seems to be much more susceptible to this deficiency than the apple, although four cases of copper-deficiency symptoms have been found in apple trees. This deficiency has also been seen in almonds and a number of ornamental trees. In no instance have symptoms of this trouble been observed in plum trees, even where these are being grown on soils known to be deficient in copper. Copper deficiency has been seen in a number of pear varieties, including *Conference*, *Laxton's Superb*, *Comice*, *Buerré d'Amanlis*, *Beurré Superfin*, *Williams*, *Pitmaston Duchess*, *Dr. Jules Guyot* and *Winter Nelis*. Of these, *Beurré d'Amanlis* appears to be particularly susceptible. The deficiency has also been seen in Cox's and a number of other apples.

Symptoms of copper deficiency seen in pears have included the summer die-back of growing points, leaf necrosis, and rough bark. In addition, in young nursery trees in early summer, the deficiency has been seen to result in a " witch's broom " type of production of crowded new shoots. The leaves formed on these shoots are rather pale in colour.

The results of soil analysis with the *Aspergillus niger* test, carried out at Long Ashton Research Station on samples from the Lower Greensand at three centres in Wiltshire, are given below. A comparison is made with known copper-deficient soils at Wisley, Surrey.

In each of the cases in Wiltshire, characteristic summer die-back and other symptoms were seen : at Oare these occurred first in pears, while at Devizes and Lower Chapmanslade both apples and pears were affected.

**Level of Copper in Soil (parts per million)**

| Depth of Sample | Lower Greensand, Wiltshire | | | Wisley | Threshold Deficiency Level |
|---|---|---|---|---|---|
| | Lower Chapmanslade | Devizes | Oare | | |
| *Inches* | | | | | |
| 0-6 | 2.0 | 2.0 | 1.0-1.6 | 0.6-2.0 | 2.0 |
| 6-12 | 1.4 | 1.8 | 1.2-1.6 | 0.2 | |

## Zinc Deficiency

Zinc deficiency has been found at the nursery in Devon where copper deficiency has also been seen. In this case, apples and cherries appeared to be more susceptible than pears, while plum trees seemed less affected. One borderline case of zinc deficiency was found in a young orchard of

dwarf pyramid apples at Tibberton in Gloucestershire, and a further case of possible slight zinc deficiency was seen in pears at Milbury Heath in the same county. In the apple trees at Tibberton only very slight rosetting of the leaves was seen, together with some checking of growth. The pears at Milbury Heath showed very slight leaf rosetting only.

Leaf samples taken from apple and pear trees suspected of either copper or zinc deficiency were analysed and the resultant figures are as follows. Comparative figures for Wisley and Long Ashton are included.

**Copper and Zinc in Dry Matter of Leaves (parts per million)**

| | Exminster, Devon | | | Kingston Langley, Wilts | Wisley | Long Ashton |
|---|---|---|---|---|---|---|
| | Standard Apple Trees | | Pear | Apple | Apple | Apple |
| | Lower Leaves Showing Zinc Deficiency | Higher Leaves Showing Little Zinc Deficiency | Showing Copper Deficiency | Suspected Copper Deficiency | Showing Copper and Zinc Deficiency | No Symptoms of Copper or Zinc Deficiency |
| Copper | 2.2 | 2.5 | 1.1 | 2.3 | 1-2.5 | > 5 |
| Zinc | 14.1 | 15.4 | 17.8 | 23.0 | 2-10 | >20 |

Dry-matter content of shoot growths, taken from copper-deficient pear trees in Wiltshire during the dormant season, was found to be 1.3-1.5 parts per million of copper.

## Correction of Copper and Zinc Deficiencies

Spraying of affected trees with a proprietary copper oxychloride spray at half the recommended strength for use as a summer fungicide on fruit trees, or with 0.05 per cent copper sulphate during the last week of May, have both given good control of copper deficiency in the year of application. In Devon a soil application of copper sulphate at the rate of 50 lb. per acre, put on with sand as a carrier in February, gave no control during the first season, but the trees responded well in the second year. Applications of from 25 to 50 lb. per acre copper sulphate are now being used to correct copper deficiency, and the mixing of the copper sulphate with routine fertilizer applications is being tried out. Such ground dressings of copper sulphate are unlikely to give satisfactory results on alkaline soils.

Zinc deficiency has been controlled satisfactorily by the application of 4.0 per cent zinc sulphate during the dormant season in February, or at the rate of 0.1 per cent in spring when sufficient leaf has developed. The spring application proved as satisfactory as the dormant season one,

and would normally be advised since very much less material has to be used. In either case, one application has been found to give control extending over a period of at least two seasons.

## Use of Foliage Sprays of Urea for Nitrogen Deficiency

Preliminary observations carried out on the use of urea foliage sprays on fruit trees during 1950 and 1951, showed that this material is readily taken up by the leaves of both pear and apple trees. Leaf analysis showed that the nitrogen status of the leaves of the sprayed trees was increased, and where the general level of nitrogen was low, there was visual improvement in the sprayed trees. The results obtained in two cases on the up-take of urea as shown by leaf analysis are given below.

James Grieve Apples, Budleigh Salterton, Devon. The orchard in this case was grassed down and the trees were not showing sign of nitrogen deficiency. Those sprayed received two pre-blossom and one post-blossom application of urea at the rate of 5 lb. urea per 100 gallons, included in the green-cluster, pink-bud and petal-fall lime sulphur sprays. The control trees received the scab sprays alone.

| Date of Sampling | Percentage Nitrogen in Leaf Dry Matter | |
|---|---|---|
| | *Control* | *Sprayed Trees* |
| 1950 | | |
| June 2 | 2.90 | 3.21 |
| July 6 | 2.60 | 2.59 |
| Sept. 22 | 2.25 | 2.21 |

It will be noted that after an initial increase in the nitrogen level of the sprayed trees the level fell later in the season, and eventually reached approximately the same level in both control and sprayed trees. It is, of course, likely that the initial up-take of urea resulted in greater leaf growth until the relative analysis figures in both control and sprayed leaves were the same. No damage was caused by the urea spray.

Pears, Milbury Heath, Gloucestershire. Nitrogen-deficient *Conference* and *Comice* pears growing in grass were sprayed with urea at the rate of 5 lb. per 100 gallons, one application being applied pre-blossom at the white-bud stage, and two applications post-blossom at the petal-fall stage and two weeks later. The results of leaf samples taken in June and July 1951, are given in the table opposite.

As in the case of the apples in Devon, the urea applications gave an initial increase in the nitrogen level in the leaves, and this was reflected to a certain extent in the leaf growth and colour, although the results were not very marked. No damage was caused by the urea.

| Variety | Date of Sampling | Percentage Nitrogen in Leaf Dry Matter | |
|---|---|---|---|
| | | 3 *Urea Sprays* | *Control* |
| | 1951 | | |
| Conference .. .. | June 15 | 2.37 | 2.18 |
| | July 20 | 1.98 | 1.82 |
| Comice .. .. | June 15 | 2.13 | 1.88 |
| | July 20 | 1.64 | 1.64 |

Observations during 1952. Observations on the use of urea sprays to correct nitrogen deficiency were made at two centres in 1952 : one a continuation of that made in 1951 at Rewe Fruit Farm, Exeter, on very nitrogen-deficient Beauty of Bath apples, and the other on very nitrogen-deficient black currants near Wimborne, Dorset.

In the case of the black currants—where, in spite of heavy dressings of nitrogenous fertilizers, it has been found very difficult to correct nitrogen deficiency induced by excessive mulching in the past with sawdust—encouraging response was obtained in 1952 by spraying urea at the rate of 20 lb. per 100 gallons. The trial was a preliminary one, designed to test the effect of the urea on the bushes, and the result appears to be that the 2 per cent application was more satisfactory than a $\frac{1}{2}$ or 1 per cent application. No damage was caused by this 2 per cent spray, and a secondary effect noted was that there was considerably less Leaf Spot (caused by the fungus *Pseudopeziza ribis*) on the treated bushes. This is interesting in view of previous work on this disease carried out at Long Ashton Research Station, where it was observed that black-currant bushes with a high potash/nitrogen ratio showed much more Leaf Spot than those with a lower potash/nitrogen ratio. It seems possible that by the application of the urea, the potash/nitrogen ratio may have been lowered sufficiently to cause delay in the development of the fungus. Further observations on this point, in trials specifically designed for the control of Leaf Spot, are being made in 1953.

In the trial at Rewe Fruit Farm, the same Beauty of Bath apple trees were sprayed and the same control blocks used as in 1951. Each block consisted of three rows of five trees, each under grass. In 1951 the sprayed trees received two applications of urea at 5 lb. per 100 gallons in the green-cluster and pink-bud scab sprays. In 1952 the sprayed rows had one application of urea at the rate of 5 lb. per 100 gallons of spray included in the pink-bud lime sulphur, put on at the rate of 400 gallons of spray per acre (i.e., the trees received urea at the rate of 20 lb. per acre). Although comparatively little leaf had developed by this time, it seems probable, following work done in Michigan, U.S.A., that the urea is to a large extent absorbed direct through shoot and wood growths and the bark of the trees. Some must also, of course, find its way into the trees via the root system.

The general result of the applications of urea was to give better leaf growth and colour throughout the summer. The improved leaf development was marked even at the petal-fall stage—only a few weeks after the application of the urea. Assessments made of leaf colour and growth during June and July showed that most of the sprayed trees developed better foliage and made more extension growth than the unsprayed trees.

An assessment of fruit set made in 1952 at the early fruitlet stage, showed that the set was better in the case of trees which received urea in the pink-bud spray. The final crop in both 1951 and 1952, in general, confirmed the better yield from the sprayed trees. The quality and size of fruit from the sprayed trees was noticeably better than from the control trees. No noticeable effect on the amount of Apple Scab on the fruit or trees at time of picking was seen.

## Suggested Uses of Urea

As the result of this experience it is suggested that applications of urea as a foliage spray may be useful in helping to correct severe nitrogen deficiency where a quick response is required, or where it is difficult to make nitrogen available to the trees or bushes through soil applications, as, for instance, where sawdust has been used in excessive quantities.

It is considered that urea may be useful for application to nitrogen-deficient trees to supplement, but not replace, the ground applications of fertilizers. Urea sprays may prove of value, however, when very dry periods are experienced in spring, so that the effects of ground dressings of nitrogenous fertilizers are therefore not available until late in the season.

If the intention is to improve fruit-set in the first year of application, it is suggested that it is essential to add the urea to one or more of the pre-blossom sprays. For increased growth later in the season, it is probably advisable to add the urea to two or more of the post-blossom sprays. At the rate of 5 lb. per 100 gallons of wash, the latter being applied at 300 to 400 gallons per acre, it gives an equivalent of 15-20 lb. of urea (48 per cent nitrogen) per acre, which is equal to 34-46 lb. sulphate of ammonia per application.

According to work in the United States, the urea is very quickly absorbed by the leaf surface, and this has been apparent in work done in the south-west. No damage has occurred where the urea has been added to routine lime sulphur sprays if no other salt, such as magnesium or manganese, has been used at the same time.

### Acknowledgment

The writer acknowledges the interest shown and help given in the analysis of soil and leaf samples by Dr. D. J. D. Nicholas of Long Ashton Research Station, and Messrs. J. B. E. Patterson and Mr. J. Langmead of the Soil Chemistry Departments at Bristol and Starcross.

E43598 Wt.55-43 K27 6/53 Gp.8 Fosh & Cross Ltd., London

AGRICULTURAL RESEARCH COUNCIL

# QUANTITATIVE INHERITANCE

*Edited by*

**E. C. R. REEVE, B.A., Ph.D.,**
**and Professor C. H. WADDINGTON, Sc.D., F.R.S.**

The papers reproduced in this volume were read at a colloquium held in Edinburgh in 1950. They include a theoretical discussion by Professor Sewall Wright of Chicago, and descriptions of several extensive experiments by Professor Mather and by members of the Agricultural Research Council's staff at the Institute of Animal Genetics. Among the purposes of the colloquium were the discussion of the validity of the basic biological assumption on which the statistical theory is based, and the attempt to decide what new theoretical developments are most urgently required.

9 illustrations. 152 pp.

*Price 20s. (By post 20s. 3d.)*

---

*Obtainable from*

HER MAJESTY'S STATIONERY OFFICE

at the addresses on the reverse of the
title page or through any bookseller

**MINISTRY OF AGRICULTURE AND FISHERIES**

# *PLANT PATHOLOGY*

A new quarterly publication presenting original contributions on plant diseases, plant pests, rodent and bird damage, nutritional and physiological disorders of interest to the mycologist, entomologist, helminthologist, soil or nutrition chemist, plant physiologist and meteorologist.

Single Copies 4*s.* (4*s.* 1½*d.* by post)
Yearly Subscription 16*s.* 6*d.* (including postage)

*For new readers...*
back numbers are available

from

**H.M. STATIONERY OFFICE**

York House, Kingsway, London, W.C.2 423 Oxford Street, London, W.1
P.O. Box 569, London, S.E.1
13a Castle Street, Edinburgh, 2 1 St. Andrew's Crescent, Cardiff
39 King Street, Manchester, 2 Tower Lane, Bristol, 1
2 Edmund Street, Birmingham, 3 80 Chichester Street, Belfast
or from any Bookseller

S.O. Code No. 72-20-6-